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# **Civil Works Operations & Maintenance Management Tools Research Program**

## **Program Summary FY 2000 – FY 2002**

David T. McKay and Stuart D. Foltz

January 2005



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## **Final Report**

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**ABSTRACT:** The purpose of the Civil Works Operations & Maintenance Tools (O&M Tools) research and development program was to develop new decision support tools and improve old ones that could remove a degree of subjectivity from the business of developing and executing the O&M program. The products would help managers not so much by making decisions for them, but by providing a structured basis of objectivity and fact as a platform to support decisions where choices are difficult to make. The products focus on infrastructure condition assessment, infrastructure functionality evaluation, analyses which would project benefits derived from O&M investments, prioritization algorithms based upon consequences and probabilities (risk) which would be used to rank proposed work packages in the O&M budget, and lastly, an inexpensive means for communication within the U.S. Army Corps of Engineers' (USACE's) O&M community by way of a web site that catalogs cost savings technologies. The 3-year program's scheduled funding was cut more than 50 percent during its first 2 years and received only enough funding during the final year to partially complete some efforts and summarize the achievements described in this report.

Simplified Condition Index Methods for Miter and Tainter Lock Gates and Tainter Dam Gates were developed, but field testing was not completed because of funding cuts and consequently the technology was never transferred to the field. As such the simplified miter and tainter gate Condition Index procedures are incomplete, though the preliminary results indicate a time savings of 50 to 75 percent is possible in most cases. A draft report for the simplified horizontally framed miter gates, simplified vertically framed miter gates, and simplified tainter dam and lock gates appear as Appendices A, B, and C, respectively, in this report.

An Alternative Simplified Condition Index Method for Tainter Gates and Mechanical Equipment and Brand New CI Methods for Lift Gates, Electrical Equipment, Operational Procedures, and Additional Mechanical Equipment were developed based on a checklist approach. The work was completed through a leveraged collaboration with Canadian hydropower concerns. Due to funding cuts, these checklists were not fielded in the COE. The inspection checklists are included in Appendix G.

The Benefits Analyses work was re-focused on prioritization by the Field Review Group (FRG) after the first year. During that first year, however, several models were compared with each other. These models originated from the hydropower and dam safety programs. Preliminary results indicate that a significant amount of effort would be required to develop a reliable and consistent benefits analysis model.

Two similar Prioritization Models for non-deferrable work packages were cooperatively developed by the Southwestern Division and the Great Lakes and Ohio River Division and used to assist the O&M budgeting process. These models are discussed in a chapter of this report.

A Web-Based Catalog of Cost Saving Technologies that were proven successful in the field, with associated links to points of contact as well as links to technology documentation, was created. More than 150 technologies are listed. The catalog exists today but has no support funding.

The concept of a Summary Index (first proposed in an earlier Civil Works Operations Division sponsored research and development [R&D] program) was dropped by the FRG after the first year and never revived. The concept had two objectives: (1) formulate roll-ups of component CIs into a comprehensive single summary index for an entire project and (2) develop a methodology for a group of components within an O&M work package termed a composite index. There were numerous opinions on what the SI could or should do; this made formulating a strategy for development difficult and caused the concept to be dropped after the first year.

A 2-day workshop was attended by 10 people representing Operations and Plans & Programs. During the workshop, the beneficial uses of the O&M Tools were discussed, and an idea for a Report Card for Civil Works Infrastructure was formulated. It would be similar to the report card produced by the American Society of Civil Engineers (ASCE), only it would require more objective grading metrics. It would annually grade (from A+ to F) each of the Operations Business Areas (e.g., Navigation, Flood Damage Reduction, Hydropower, etc.) according to the overall health of each infrastructure type. It would be based on objective data, open to all for scrutiny, and be endorsed by the Chief of Engineers. Such a tool might be persuasive and used to advantage by the USACE. The idea has been proposed but re-mains unfunded.

During the same workshop, the problem of Managing Corporate Data was defined by USACE field personnel. Despite efforts such as Operations Management Business Information Link (OMBIL), which is supposed to centralize data input, many systems within OMBIL still require duplicative data. Also, there are additional unlinked systems, including new and emerging systems such as the CIs, Facilities and Equipment Maintenance System (FEMS), Dam Safety Program Management Tools (DSPMT), and others that ultimately force duplicative data entry into multiple systems. A piece of data should be entered once and only once. This management idea has been proposed but remains unfunded.

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## Acronyms

ABS	Automated Budget System
ASCE	American Society of Civil Engineers
BUREC	Bureau of Reclamation
CECW	Corps of Engineers Civil Works (Directorate of Civil Works)
CECW-O	Directorate of Civil Works, Operations Division
CEFMS	Corps of Engineers Financial Management System
CERD	Corps of Engineers Research and Development (Directorate of R&D)
CERD-C	Directorate of Research and Development, Civil Works
CERL	Construction Engineering Research Laboratory
CI	Condition Index
COE	Corps of Engineers
DSPMT	Dam Safety Program Management Tools
DV	Deduct Value
EC	Engineer Circular
E&D	Engineering and Design
EIG	Engineer Inspector General
EM	Engineer Manual
EMS	Engineered Management Systems
ERDC	Engineer Research and Development Center
FAB	Field Advisory Board
FDR	Flood Damage Reduction
FEMS	Facilities and Equipment Maintenance System
FRG	Field Review Group
HDC	Hydroelectric Design Center
HQUSACE	Headquarters United States Army Corps of Engineers
ISR	Installation Status Report
IPR	In Progress Review
IWR	Institute for Water Resources

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LDI	Lock & Dam Investigations, Inc. (contractor)
LIDAR	light detection and ranging
LRD	Great Lakes & Ohio River Division
MLI	Multi-Level Inspection
MVD	Mississippi Valley Division
NJV	Noise, Jump & Vibration
NPS	National Park Service
OE	Operating Equipment (usually for varieties of gates)
O&M	operations and maintenance
OMB	Office of Management & Budget
OMBIL	Operations & Management Business Information Link
PMCL	Planning & Management Consultants Limited (contractor)
PMF	Probable Maximum Flood
PAT	Process Action Team
PMBP	Project Management Business Plan
RACM	risk assessment criteria matrix
REMR	Repair, Evaluation, Maintenance & Rehabilitation
R&D	research and development
SAD	South Atlantic Division
SI	Summary Index
SWD	Southwestern Division
TVA	Tennessee Valley Authority
USACE	U.S. Army Corps of Engineers



## Preface

This research was conducted for Operations Division, Directorate of Civil Works, Headquarters, U.S. Army Corps of Engineers under PROMIS #0089S0, S2 “O&M Management Tools.” The original technical monitor was Harold Tholen (CECW-O). James D. Hilton (CECW-OD) took over after Mr. Tholen’s retirement.

The work was performed by the Facilities Management Branch (CF-F) of the Facilities Division (CF), Construction Engineering Research Laboratory (CERL). The research effort was coordinated by Mr. David T. McKay and Mr. Stuart D. Foltz. Part of this work was done by Lock and Dam Investigations, Inc., Ames, IA, under DACW42-00-P-0594 and DACA42-01-D-0010. The technical editor was Linda L. Wheatley, Information Technology Laboratory — Champaign. Mark W. Slaughter is Chief, CF-F, and L. Michael Golish is Chief, CF. The Technical Director of the Facility Acquisition and Revitalization business area is Dr. Paul A. Howdyshell, and the Director of CERL is Dr. Alan W. Moore.

CERL is an element of the Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Commander and Executive Director of ERDC is COL James R. Rowan, EN, and the Director is Dr. James R. Houston.

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# 1 Introduction

## 1.1 Background

The U.S. Army Corps of Engineers (USACE) annual Operations & Maintenance (O&M) budget for Civil Works is developed over a 2-year cycle and executed within 1 year by a broad spectrum of USACE professionals. The cycle begins 2 years before actual funds allocation, with guidance provided by the Office of Management and Budget (OMB) through Headquarters, USACE (HQUSACE). Engineer Divisions and Districts are tasked to identify program requirements, resulting in some 15,000 to 20,000 O&M work package proposals per year.

Because it is impossible to fund every proposal, the packages must be prioritized. The ranking of these packages is accomplished primarily by consensus and is relatively straightforward. The ranking becomes more difficult, however, when the proposed program's requirements approach the expected limit of funds. At this point, more scrutiny and deliberation are dedicated to the work packages that are on the margins of possible funding. The stakeholders of work packages that 'just miss' being funded understandably want well supported explanations, but all too often the explanations appear to be subjective at best. For example, no fixed criteria have been developed to weigh the merits of a navigation package versus a flood control or hydropower package. This subjectivity is especially troublesome to stakeholders when work critical or non-deferrable work packages fail to make the funding cut. The result has been a growing backlog of critical maintenance and repair. The people tasked with ranking the priority of dissimilar competing work packages find the work frustrating and difficult, and welcome any data or documentation that would bring more objectivity to the process.

When the O&M program requirements are finally determined, they are aggregated and staffed up the Corps chain of command, with reviews at every level including OMB, the Congress, and the President before appropriations are finally made. Yet, paradoxically, with so much attention and deliberation expended on this funding process, the O&M appropriation and the subsequent allocations down through Corps activities still tend to be *target-based*. Target-based budgeting may be loosely

defined as ‘what worked last year will work this year with some adjustment for new projects, unusual circumstances, and so on.’

Various external issues not directly related to the merits of project O&M requirements also have made it more difficult for the Corps to gain approval of funding levels required to avoid working in ‘breakdown mode.’ The problem of aging infrastructure that is being used beyond its design life may seem relatively mundane or low-a priority to decision-makers in the executive or legislative branches. As has been stated so often before, the competition for public funding from all quarters continues to grow each year.

To summarize the problem, Corps O&M investment in aging Civil Works infrastructure has been hampered by the traditional culture of target-based budgeting, growing competition for public funds, and a lack of empirical data that objectively demonstrate the true cost of continually postponing critical maintenance. All of these conditions have made it very difficult for the Corps to present an objective yet forceful argument for greater O&M investment levels that are sufficient to meet the critical infrastructure needs identified in the field.

In fall 1998, Corps divisional operations chiefs prepared an internal working document entitled *Point Paper for Director of Civil Works / Most Important Things To Do in Managing the O&M Program Through 2005 (MSC & HQ Operations Chiefs’ Top Ten plus 1)*. Of the top priorities for improving Civil Works O&M management discussed in this paper, two were directly addressable through the development and use of engineered decision support tools. Quoting from this working document, these two priorities were:

**Item 7 — Develop Tools To Uniformly Set Priorities Nationwide For Maintenance Needs.** The Corps has historically set funding priorities in a manner that factors in critical public interest factors, costs, and the need for the maintenance. However, there is currently no structured method, with repeatable results, for establishing these funding priorities. A potential method includes simplified existing tools that the Corps has developed (Condition Indices, master planning, Quadrant, Activity-Based Costing, etc), integrated with assessments of the risks associated with not doing the maintenance, and the public interest in conducting the work. This method must be an easily used, quantifiable tool that can be used nationwide, providing uniform results. Other potential tools to aid in structured approaches to maintenance management include the Facilities and Equipment Maintenance (FEM) system and other inventory management systems. Ac-

tion: HQ Operations collaborates on development of simplified risk-based tools in conjunction with CPW. Timeline: 120 – 180 Days.

**Item 9 — Challenge Inspection Levels And Inefficient Requirements.** In February 1998, HQUSACE initiated a review to identify areas where inspection levels and regulatory requirements could be reduced or eliminated with little additional risk. Some of the activities include real estate utilization inspections, comprehensive periodic inspections of project structures, annual pesticide reports, etc. Reduced requirements can decrease both off-site and on-site costs. Action: HQ Operations, Engineering and Real Estate Process Action Team reviews MSC recommendations for inspection level and frequency changes. Establish risk-based inspection criteria. Timeline: 120 – 180 days.

This consensus of operations chiefs provided the impetus for proposing development of a suite of O&M management tools for improving the operation, safety, and cost-effectiveness of Corps Civil Works projects.

## 1.2 Objective

The objective of the Civil Works O&M Tools research project (hereinafter referred to as “O&M Tools” or simply “tools”) was to develop new methods (and improve on existing ones) for eliminating the aspects of subjectivity that negatively impact effective development and execution of the Corps O&M program. These tools would support Corps decision-makers with objective data and engineering-based guidance for making informed, pragmatic choices in terms of funding and prioritization.

## 1.3 Approach

The research was intended to address the following distinct problem areas of concern to the O&M management community:

- slow adoption of established condition indexing systems due to their associated levels of effort and expense to implement
- difficulty making defensible cost/benefit comparisons between work packages for different types of Civil Works projects
- real and perceived subjectivity in the prioritization of work packages

- lack of Corps-wide awareness of applicable technological products and solutions successfully implemented at a few local sites

The following work units were organized to develop solutions for these problems:

- **Condition Index Simplification.** Previously established Condition Index (CI) systems were targeted for simplification to make them easier, faster, and less resource-intensive to adopt by the end user. This effort would also develop new simplified CI systems to meet additional needs at the project level.
- **Benefits Analysis Tool.** This tool would be developed to calculate tangible benefits associated with proposed O&M work packages. It would be used to compare the absolute, quantifiable aspects of very different kinds of operational maintenance (e.g., flood damage reduction versus hydropower improvement). Theoretically, such a tool could be scaled up for application to work activities larger in scope, such as multipurpose structures or entire Corps Civil Works projects. In the second year of this work unit, the focus was changed to work package prioritization by the Field Review Group (FRG). The metric for prioritization would be driven by data and objective engineering-based criteria to the extent feasible, but more qualitative elements were subsequently introduced by the FRG. The overall intent of the work unit was still to provide a more pragmatic, consistent, and uniformly applied methodology for making decisions about advancing or deferring work packages.
- **Summary Index.** This tool would be developed to (1) formulate roll-ups of component CIs into a single, comprehensive index for an entire project and (2) develop a methodology for indexing a group of components within an O&M work package (termed a composite index).\*
- **Web-Based O&M Technology Catalog.** This product would be a web-based clearinghouse of information on proven cost-saving O&M technologies used or demonstrated within the Corps but not yet widely adopted. As a mode of technology transfer, the web-based catalog would promote cost reduction throughout the Corps and help to capture and retain knowledge that otherwise is lost when expert personnel retire.

The multi-year research project was funded annually as a remaining line item in the O&M budget (Figure 1). The work was executed through a series of interviews, site visits, field tests, and workshops. Two contractors were utilized: Planning

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\* This idea was discontinued by the FRG after the first year.

Management Consultants Limited, Carbondale, IL, and Lock and Dam Investigations, Inc., of Ames, IA. The program received guidance from an annual FRG including Corps program sponsors, the directorates of R&D and planning, and representatives from the field working at the division, district, and project levels.

Civil Works O&M Management Tools Funding Summary (\$1000)								
	FY00		FY01		FY02		totals	
	scheduled	actual	scheduled	actual	scheduled	actual	scheduled	actual
Program	1050	485	1000	505	350	100	2400	1090
Simplified CI		194.0		277.8		50		521.8
Benefits Analyses		97.0						97.0
Prioritization				176.8		50		226.8
Summary Indexes		48.5						48.5
O&M Handbook		145.5		50.5				196.0
Contract		90		90				180
In House		395		415		100		910

Figure 1. Three-year funding totals for O&M Tools research project.

## 1.4 Scope

A note is offered here about use of the term “CI” (condition index) in this report. The original Corps of Engineers Repair, Evaluation, Maintenance, and Rehabilitation (REMR) management systems from which the objective condition indexing methods emerged were delivered in three parts:

1. the condition inspection procedures and the algorithms that produced the actual CIs (at component and subcomponent levels)
2. the software program for automated application of the algorithm and storage of the data
3. the technology transfer process of training personnel on the usage of the inspection procedures and supporting software tools.

In this report, the term CI may refer to the computed index for a component or subcomponent, but unless otherwise stated it most often refers to the concept of objective condition assessment based on well defined, repeatable methodologies for specific types of structures and components.

## 1.5 Mode of Technology Transfer

The products of this research are appropriate for technology transfer through workshops and training sessions. The web-based O&M technologies catalog was completed and put online at the following location:

<http://www.cecer.army.mil/pl/omhandbook/>

More information is available in Chapter 4. Due to the reprogramming of funds originally dedicated to this research effort, the other work units were terminated before the scheduled products were ready for transfer.

In accordance with Public Law 96-480, the potential for successful technology transfer to state agencies, local governments, and the private sector was assessed. It was determined that information and data produced in this work unit has low potential for application outside of the Corps of Engineers mission.



## 2 CI Development and Simplification

### 2.1 Introduction

Although the Corps has developed many condition indexing (CI) systems over the years under the REMR program (Appendix M), there are still classes of Civil Works infrastructure for which CIs have not yet been developed (e.g., levees, groins and bulkheads, floodwalls, pumping equipment, protective coatings). Some of the existing systems need additional features or other enhancements (e.g., tainter gate trunnion friction and corrosion rates for both embedded and open gate anchorage systems), and others require major revisions (especially hydropower).

CI systems are not used more widely throughout Corps projects because many field offices perceive them to be complicated and time-consuming, but lacking in sufficient payback to warrant the investment of effort. Although CI data were once a required part of the process for developing budget needs per Engineer Circular (EC)-11-2-183, the instructions for including these data were inconsistent with the manner in which CI data are obtained and filed. The consequence of this inconsistency was that the instructions for incorporating CI data were either ignored or incorrectly applied. In order to promote the benefits of CI systems throughout the Corps, the objective of this work unit was to simplify them to the extent that using them would be straightforward for the end user and immediately advantageous to the project.

The CI Development and Simplification work unit was organized into four related efforts:

- **System Simplification.** Reduce the time and effort required to apply them while maintaining a requisite level of engineering rigor. One task focused on simplifying the measurement methodology; the other attempted to rethink the established approach to Civil Works inspections by developing a ‘context sensitive’ inspection practice that correlates the scope and level of detail (i.e., effort invested) to the goals of the specific inspection requirement. The prod-

ucts of this two-pronged effort were (1) a Simplified CI process and (2) a Multi-Level Inspection (MLI) protocol.

- **Checklist Simplification.** Develop new, highly simplified CI systems based solely on new or existing inspection checklists. This effort, leveraged through a research and development (R&D) partnership with a Canadian hydropower utility, developed the 'low-end' option for conducting inspections using simple, rational checklists as the inspector's key tool. These checklist-centered procedures are suitable for incorporation into lower-intensity MLI protocols.
- **New CI Requirements.** Identify Civil Works infrastructure components for which no CI system has been developed but which have been asked for in the field.
- **CI Enhancements.** Identify and implement steps to improve existing CI systems by making them produce more meaningful information than originally conceived.

Each of these separate efforts are discussed below.

## 2.2 System Simplification

The sponsor's general simplification goal was set to retain 80 percent of an existing system's value (i.e., technical integrity) while cutting more than 50 percent of the original effort. Considering that these targets are largely subjective, this effort had to consider how to proceed if the desired 80/50 tradeoff could not be achieved. There are any number of ways to proceed toward such a target. For example, if the effort-reduction (i.e., cost-reduction) target were held firm, the resulting product might not retain 80 percent of its value; conversely, if the 80 percent value target were held firm, it might not be possible to meet the effort-reduction target, especially for systems used on highly complex Civil Works components.

To elaborate on these dual constraints, the researchers note that simplification may save time and money, but it will tend likewise to reduce the quality and extent of information collected. The first tradeoff is that the resulting condition ratings may be less accurate; the measurements may lack their previous precision or they may be eliminated entirely, which in either case will lead to greater uncertainty about a component's true condition. A second tradeoff is that even if the accuracy of condition ratings can be preserved under a simplified system, the reduction in effort expended tends to come at the expense forfeited opportunities to view Civil Works structures at close quarters. Such observations present a structured opportunity to

examine details often overlooked in daily operation or other inspections, even if those details aren't codified on inspection checklists.

For these reasons, then, the 80/50 tradeoff could not be interpreted as a literal target for the CI simplification work, but it was considered to be the general guideline for a desirable result.

### **2.2.1 Simplified CI Inspection Process**

Starting with rigorous inspection processes that are part of the established Corps condition indexing systems, the basic approach to simplification was to time every step of a standard inspection with a stopwatch and evaluate the impact of either simplifying that step or eliminating it. This approach, called *simplification by minutiae reduction*, helped the research team to focus on what is most important to the people who are responsible for a component's operation. Using this process evaluation methodology, some complicated steps were greatly simplified and others were completely eliminated. The minutiae reduction approach was applied to tainter dam, tainter lock, and miter lock gates as well as the concrete in lockwall monoliths. Significant time was saved by specifying that binoculars may be used to look for signs of cracks, dents, corrosion, etc., instead of making close observations from a boat. Of course, if inspection by binoculars revealed a distress of any significance, the inspection procedure would specify closer examination by boat. For the concrete in lockwall monoliths, replacing the boat inspections with observations from the deck with binoculars reduced the time needed from 6 hours to less than 2.

All existing gate CIs were scrutinized, and all feasible ways were considered to simplify the inspection while retaining about 80 percent of its informative value. Preliminary results showed that, in many cases, a 50 to 75 percent reduction in the original inspection time could be realized. Setting up the equipment has always been the major time-consumer for gate inspections. Once the necessary gages and transits are in place, the action of taking measurements literally requires only a few minutes. With this in mind, the researchers attempted to identify which measurements were most meaningful for O&M and which ones required the most accuracy. A list of proposed procedural changes was developed, but work unit execution was terminated due to reprogramming of the committed funding. Consequently, no acceptance tests were performed with untrained personnel to verify whether the inspections had in fact been simplified to an acceptable level.

Documentation of the initial CI simplification efforts and field tests for miter and tainter gates are contained in Appendix A, “CI Simplification for Horizontally Framed Miter Gates”; Appendix B, “CI Simplification for Vertically Framed Miter Gates”; and Appendix C, “CI Simplification for Tainter Dam and Lock Gates.”

### **2.2.2 Multi-Level Inspection (MLI) Approach**

CI inspections can provide valuable information about the condition of a structure. CI procedures for navigation structures have been recognized as a useful tool for benchmarking\* a structure’s condition and functionality. There are times, however, when a full inspection requires more effort and provides more information than the situation warrants. Similarly, a simplified inspection may not provide adequate scope or detail, in which case a full CI inspection, or even investigations beyond the extent CI procedures may be needed. Because of condition information requirements that may vary depending on the context in which the inspection is conducted, a multi-level condition assessment methodology would be very useful for adjusting the level of inspection effort to the quality of data needed for current purposes. The key determinants of inspection procedures would be the nature of the *need* for an inspection, the *scope* of information required, and the level of *detail* desired. This is not a new idea and is in fact the kind of engineering routinely practiced in Corps offices by seasoned management teams, but the Corps currently lacks definitive, codified procedures that would provide consistent, repeatable CI inspection results Corps-wide.

The first necessity for codifying a multi-level inspection procedure is to define the nature of the *need* (i.e., the goal) for an inspection. There are numerous reasons for initiating a condition assessment. It may be that the appropriate calendar interval has passed, such as the 5-year interval for periodic inspections. At another time, the assessment may be initiated as part of a program to benchmark the condition level of a structure. Other reasons could be to determine the extent of damage, or to evaluate repair options for damage or for normal deterioration.

The condition assessment *scope* defines how broad or narrow is the focus of the assessment. A broad scope could involve the assessment of all the structures within a project, as might be the case for a current periodic inspection. In contrast, the scope

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\* Benchmarking: establishing a reference status where condition levels of all components are quantified, which is readily accomplished with CIs.

might address a single subcomponent such as a tainter gate, similar to the scope of the current REMR CI inspection procedure. Taken to an extreme, the scope could be as narrow as assessing a single coupling within one set of operating equipment, or perhaps the upper anchorage on one leaf of a miter gate set. The management team would determine scope on the basis of the need the condition assessment.

The *level* of detail needed from the condition assessment gives the management team the ability to choose, in conjunction with scope, how much effort would be appropriate to invest in a given assessment. Again, the management team would make a determination of level based on the *needs* component in the decision.

Adhering to this approach, variable-intensity inspections might become the norm for broad-scope condition assessments. To illustrate, let us assume that the calendar dictates an inspection for a lock and dam. Under normal conditions, nearly all components would be inspected at less than full scale level because the lock personnel and operations staff already have a good grasp of the condition of their structures through daily exposure. Such day-to-day knowledge may warrant a more detailed inspection, when a tainter gate groans loudly during operation, for example, or a miter gate quoin seal starts leaking badly. The appropriate level of inspection is set by the need to know what is causing such problems.

The MLI approach was proposed as an alternative to an across-the-board, ‘one size fits all’ CI Simplification. The proposed inspection levels differ in the level of effort needed to obtain specific results, and also vary according to the need being satisfied by the inspection. Three levels are specified:

- MLI Level I, or ML(I)
- MLI Level II, or ML(II)
- MLI Level III, or ML(III).

ML(I) describes what one should do to make a CI evaluation of a component without leaving one’s desk. The assessment may be based on personal knowledge of the component’s condition, or its maintenance history, or data that are already available elsewhere. Circumstances where a Level I inspection is neither appropriate nor adequate are described, such as when a long time has elapsed since the previous physical observation. Under such circumstances, an ML(II) may be recommended.

ML(II) requires a site visit with a checklist of simple observations including some multiple choice questions requiring knowledge of the component’s current operational status. Only the simplest of measurements, if any, are specified. Based upon

the results, the required CIs or data may be determined. If indices or data cannot be determined by an ML(II) inspection, then an ML(III) or specific elements of an ML(III) inspection shall be recommended.

ML(III) corresponds to the simplified CI inspections described under “Simplified CI” above (sometimes called “Simplified Level III”) and/or the complete original CI inspection procedure. Again, the purpose of the inspection will be the factor that controls the amount of resources invested in the specific effort.

As noted previously, the CI simplifications were not fully developed and acceptance-tested due to reprogramming of research funds. Progress was made in developing ML(I) and ML(II) level inspections for miter gates, tainter dam gates, and tainter lock gates. Reports and inspection forms for these systems are found in Appendix D, “Multi Level (I) Evaluation of Miter and Tainter Gates”; Appendix E, “Multi Level (II) Inspection of Miter Gates”; and Appendix F, “Multi Level (II) Inspection of Tainter Dam and Lock Gates.”

The preliminary MLI procedures documented in Appendices D – F include preliminary suggestions for when to perform each level of inspection. The suggestions for miter and tainter gates are preliminary and untested. They do not cover all situations and may even contain contradictions, but they will help one better understand how time and money can easily be saved by using the least intensive CI inspection that will still provide the needed information. The criteria could also be applied to other component CIs. Below are some further comments on the inspection frequency for various CIs and the status of developing the multi-level CIs.

**All CIs.** A full, detailed CI inspection is recommended at least once to serve as a benchmark. As applicable, full CI inspections may also be advisable following major events such as suspected severe loadings, or poor performance, and prior to (and after) deterioration-related repairs. The authors recommend that an ML(III) be included in the regulation for conducting Periodic Inspections (ER 1110-2-XXX).

**Miter, Tainter, and Sector Gates.** Level I and II inspection criteria have been developed for miter and tainter gates but not sector gates. High head\* miter gates have smaller allowable tolerances and are therefore less forgiving; they should be inspected more frequently than are other structures (i.e., 5 years) using the original

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\* High head miter gates: width divided by height less than or equal to 0.5.

CI system unless accepted and trusted knowledge justifies otherwise; in some cases, only partial inspection on a particular subcomponent may be required (e.g., anchorage movement). Other gates could be inspected less frequently, or inspected using simplified or a reduced set of CI measurements. Some sampling may be adequate for a spillway with many identical gates.

**Tainter Valves, Butterfly Valves.** Level I and II criteria have not been developed. Lock valves should be regularly inspected using the original CI system unless accepted and trusted knowledge justifies otherwise. These components are hidden from view during normal operation and unexpected failure has a significant impact on operations. Dam valves could be inspected less frequently. Valves are the most difficult and expensive gates to safely access. Once access is set up (usually involving a crane and scaffolding) there is no advantage to conducting a simplified evaluation.

**Operating Equipment.** Operating equipment should be inspected at the same frequency as the gates or valves they operate unless it has a lower CI rating than the gates. The original CI procedure for operating equipment assemblies can also be used for Level II and III inspections. The inspection checklists can also be used. Level I criteria have not been developed.

**Hydropower.** These CIs are based on newly developed 2-tier Condition Assessment Guides that were developed in cooperation with U.S. Bureau of Reclamation, Hydro-Québec, and Bonneville Power Association. Tier 1 assessments correspond to Level I and are conducted by the project maintenance staff based on information normally available during annual overhauls. The Tier 1 assessment results in a number between 0 and 10, which corresponds to “good” (7 to 10), “fair” (3-7), and “poor” (0-3). A “poor” or “fair” assessment would trigger additional Tier 2 testing, corresponding to Level III, to identify and/or verify the problem so that an appropriate plan of action, if any, can be initiated. Condition assessment guides currently exist for turbines, generators, governors, transformers, circuit breakers, surge arrestors, emergency closure systems, and compressors. Guides for exciters, cranes, and batteries are in development. Documentation is currently in draft form. Publication is expected in the next year. Further information can be obtained from ERDC-CERL or through the USACE Hydropower Design Center.

**Embankment Dams.** Level I and II criteria have not been developed. The CI evaluation is a good opportunity for the engineers to systematically evaluate their understanding of the dam. The embankment dam CI is not an inspection proce-

cedure; it relies on existing dam safety inspection and data collection systems to provide the needed information. Problem dams should be fully evaluated using the embankment dam CI. Dams with less severe problems ( $CI > 70$ ) could probably be evaluated using a simplified CI procedure. A simplified procedure would quantify the condition but probably would not help the evaluators better understand their dam. Methodology for a simplified system has been considered but not fully developed. The embankment dam CI is not a strong candidate for simplification because, after the first application for a dam, subsequent calculations of the CI for a dam will be very quick and simple (much like a Level I or II inspection) barring major changes in the dam's performance. The embankment dam CI procedure is typically unnecessary for dams with no known problems (i.e.,  $CI > 95$ ). This CI includes an evaluation of failure modes and monitoring devices that can be performed independently. The monitoring device evaluation helps evaluate and quantify the effects of missing information. The evaluation of monitoring devices takes longer than the embankment evaluation. Some Corps dams do not have monitoring devices that warrant a CI evaluation.

**Concrete Lock and Dam Monoliths.** Level I criteria have not been developed. The simplified Level III criteria can also be used for Level II inspections. Eliminating the boat survey of the interior chamber walls can significantly shorten lock monolith inspections. The impact on the inspection results is usually minimal. In some cases, the advantages are small or there are none. When problems are visible from the deck, closer viewing from a boat may be more useful. Also, if the lock gate inspection includes a boat survey to view the gates, the concrete can be surveyed at the same time.

**Coastal Structures.** Level I and II criteria have not been developed. This CI procedure is not a good candidate for Level III simplification. Although the first application for a project can be labor-intensive, this is important to properly identify the functions and divide the structure into reaches. Beyond the physical inspection, subsequent CI ratings can be made very quickly. The CI can be calculated regardless of the inspection method used (visual, divers, soundings, LIDAR\*, etc.) and great time savings can be realized by optimal use of these methods.

**Dikes and Revetments, Steel Sheet Pile.** Level I, II, and simplified Level III procedures for CI inspection of these structures have not been considered.

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\* LIDAR: light detection and ranging; a laser-based technology for measuring distance, speed, rotation, etc.



## 2.3 Simplified Inspection Checklists

Highly simplified procedures for inspection and condition rating of tainter gates, lift gates, mechanical equipment, electrical equipment, and operational procedures were developed; these may be found in Appendix G. The checklists for lift gates, gate electrical components, and some gate mechanical components address new areas not covered by previous CIs. The checklists for tainter gates and some gate mechanical equipment provide a simpler alternative to existing CIs. These checklists correspond to ML(II) procedures.

### 2.3.1 Introduction

A CI was completed for embankment dams in cooperation with Hydro-Québec. This effort focused more on the evaluation of geotechnical performance and the importance of distresses than on the inspection and rating process for the distresses. The rating process was significantly different from most other CIs, most closely resembling the coastal CIs. Distresses are identified and severity levels described and given ranges of recommended ratings within which the inspector has much greater freedom to select the appropriate score. After completing the embankment dam CI, Hydro-Québec planned to continue complementary efforts, including one on spillway gates. This effort would include lift gates, electrical and mechanical operating equipment, and operational procedures and capabilities. This was seen as an opportunity to develop a simplified CI for these components based on different measurement and rating techniques. The decision was made to again work cooperatively with Hydro-Québec for the common benefit. Checklists for tainter gates were added to the stated objectives when the Corps agreed to participate. Later, Manitoba Hydro and Ontario Hydro joined the effort.

### 2.3.2 Spillway Checklists

The checklists developed are included in Appendix G. The four system-level checklists include gate structure (lift and tainter), electrical equipment, mechanical equipment, and operational. The ratings are for individual components, and the

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\* Access to Appendix G is limited to U.S. Government agencies only. Authorized users may obtain a copy of Appendix G from CEERD-CF-F, PO Box 9005, Champaign, IL 61826-9005.

methodology for rolling up these ratings at a system level or for a spillway has not been completed. A draft strawman diagram for spillway system evaluation is included. It is based on user evaluation of the relative importance of the subcomponents at each level but should only be considered illustrative as it is not completed nor have implementation instructions been prepared. Preliminary testing of the checklists has already shown them to have many benefits.

Speed – The checklists are very compatible with both annual and periodic inspections. Using the checklists as guides, the inspectors can quickly move from component to component, record their evaluation and comments, and proceed to the next item. The process adds little additional effort, guides the recording of information, and will reduce the potential for unfocused observation and inspection.

Completeness – In July and August 2001, USACE contractors inspected gates in three Districts. Their combined experience was nearly 100 years. They were very knowledgeable and asked many excellent questions while inspecting the gates. While USACE also has many knowledgeable engineers inspecting its dams, having that level of experience cannot be assured, so inspection criteria need to be provided to help assure review of all important aspects of gate inspection. These checklists provide this needed inspection criteria.

Quantitative – As with all CIs, benefits can be derived from obtaining quantitative ratings. Such ratings aid communication with other engineers and managers, and provide a metric for budget prioritization.

The operational checklist helps evaluate an area not previously considered in any CI. It includes the evaluation of processes, plans, and personnel readiness. Previously, all CIs considered only physical equipment and structures. Many of the plans and procedures evaluated in this new checklist are not evaluated in any other existing USACE inspections.

The inspection checklists represent a new approach to using CIs. They provide many of the benefits of more traditional CIs with much less effort. They assist in the collection and communication of inspection and condition information. Unlike more traditional CIs, they may even make existing inspection procedures more efficient, but they do not provide the same level of objectivity.

## 2.4 Identification of New CI Systems

New CI systems were identified on the basis of requests from the field during the execution of past REMR work units and development of the online O&M Tools catalog (documented in Chapter 4). A telephone survey was also conducted. The list below represents infrastructure systems or components for which new CI systems appear to be in demand:

- protective paints and coatings
- lift gates
- sluice gates
- levees
- pumping stations.

There were also queries from the field on condition indexing systems for Corps recreation facilities. Although the CI systems addressed here are specifically for Civil Works infrastructure, other systems for horizontal and vertical infrastructure on Army installations have been developed with Military Construction funding. These systems are called Engineered Management Systems (EMSs), and they have been used with success on installations as well as by public works agencies such as county and municipal governments. It was asked whether any EMSs might be useful for buildings or pavements at Civil Works facilities managed by the Districts — recreation facilities in particular. To answer this question, site visits were made to three Corps-operated recreation locations. Facilities were toured while interviewing site personnel. It was concluded that, with budgets tight and recreation work packages receiving relatively little funding, any return on investment from implementing EMSs for this purpose would probably be unimpressive.

## 2.5 CI System Enhancements

The infrastructure management information returned by some current CI systems could be more accurate or useful. Although such enhancement may not simplify a system, the additional effort needed to improve the value of certain inspection information was considered to be justifiable. Two specific enhancements were considered and/or underwent some preliminary testing:

- tainter gate trunnion friction measurements
- embedded tainter gate trunnion corrosion rate measurements.

Neither of these enhancements was implemented due to reprogramming.

## **2.6 Unfinished CI Efforts**

The tasks listed below were planned for execution during this research project but were not completed due to reprogramming:

- field validation of simplified miter gate and tainter gate inspections
- field validation of ML(I) and ML(II) procedures for miter and tainter gates
- spillway checklist component importance factors
- corporate policy/guidance for appropriate use of CIs and inspection frequency
- additional ML(I), ML(II), and ML(III) procedures for existing CI systems
- CI for protective paints and coatings
- trunnion friction measurement
- nondestructive testing of gate anchorage.

## 3 Decision Support Tool for Work Package Prioritization

### 3.1 Introduction

An original objective of this work was to develop a methodology for characterizing the benefits of a proposed O&M work package in terms of dollar value. After 1 year the FRG and researchers agreed to refocus the work unit on developing a work package prioritization methodology. This change of focus was made in part to avoid working at cross-purposes with work package prioritization efforts already underway at the Division level. Another benefit of this change was the inclusion of important non-economic criteria that should be considered in work package prioritization — safety, regulatory compliance, customer and mission impact, revenue generation, etc. Also, this change would be computationally simpler to incorporate into a user tool.

During this research ERDC/CERL worked in cooperation with several USACE Divisions and other Corps elements to develop a more effective and defensible O&M budget prioritization process. The context for these efforts was defined by four central considerations:

- Budget items are prioritized at the District level on the basis of professional and field experience, but the process is nevertheless largely subjective.
- Work packages are not always ranked solely on the basis of benefits, but may be reprioritized by managers at Districts, Divisions, or Headquarters to adjust relative funding levels among the various business areas.
- At the Headquarters and Division levels, money is typically apportioned down the organization on the basis of historical funding levels (i.e., target-based budgeting) with relatively minor adjustments made for changing needs or highly visible exigencies.
- Work package cost estimates are assigned by considering historical costs, the cost to meet a standard, or a cost/benefit judgment based on experience.

Another influence on the direction of the research was the release of an Engineer Inspector General (EIG) report on the O&M budgeting process in February 2001. Two EIG findings supported continued work in the area of budget prioritization:

**Item 3 — District and Division commanders ensure that all work packages are consistently identified and prioritized in accordance with the current series of EC\* 11-2-XXX.**

**Item 6 — Divisions continue their efforts in developing their decision support systems to more objectively prioritize their organization's work packages.**

The most important consideration in developing a work package prioritization tool is *simplicity*. There are numerous factors that should be duly considered in any prioritization process, but the need for simplicity will not allow all of these to be addressed in detail. Most Districts have to review thousands of work packages every year and do not have the time to apply complex algorithms to rank order their priorities. As a practical matter, the existing process for rank ordering is relatively straightforward and accomplished by consensus. However, difficulties arise when making decisions about work packages that fall near the budget 'cutline' in terms of priority. Due to continual uncertainties about the final level of O&M work package funding in the heat of a given budget preparation cycle, some type of objective algorithm was desired for prioritizing those work packages that fall within  $\pm 10$  percent of the anticipated cutline.

The earliest Division-level efforts to develop a work package prioritization tool were initiated by Southwestern Division (SWD) and the Great Lakes and Ohio River Division (LRD). Working groups from both Divisions attempted to determine the key rank-ordering factors, weight them, and develop scoring metrics for each. As part of these efforts, a numerous complicating factors had to be considered. Some of these factors are difficult to address at the District level because they originate either in longstanding policy decisions or the long-established Corps Civil Works business culture.

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\* EC: Engineer Circular.

## 3.2 Complicating Factors in Rank-Ordering Work Packages

### 3.2.1 *Loss of Life as a Financial Issue*

Because Corps policy does not put a monetary value on a human life, work package funding decisions do not explicitly address loss of life. Although it may seem inappropriate to account for a human death in terms of dollars, any complete dismissal of the issue has the potential to leave various risks to life unaddressed in the move to improve operational efficiency and protect government property. This is why the issue of loss of life is often considered *implicitly* during budget prioritization processes. The various groups developing prioritization tools in cooperation with this research project made the decision not to explicitly consider the relative priority of reducing potential life loss versus other desired benefits.

### 3.2.2 *Consequences versus Probability*

When projecting O&M needs 2 years or more into the future, it is critical to consider the potential consequences of uncertainty. Work package justifications often state that a component will likely fail during the year, with a consequent loss of project operation, if funding is not approved. Yet it is not difficult to find such justifications for work that goes unfunded for many years without any loss of operation. This happens because work package justifications often associate a very important failure mode with a relatively unlikely event. Thus it is important to explicitly consider both the consequences *and* the likelihood of component failure in order to prioritize diverse work packages.

### 3.2.3 *Subjective Interpretation by Different Raters*

Early test application of proposed prioritization criteria by multiple raters was too subjective, indicating that the criteria were not suitable for comparing dissimilar work packages originating in different Districts. The problem of overly subjective interpretation was reduced by improving rating factor definitions and scoring metrics.

### 3.2.4 *Prioritizing Between Dissimilar Business Areas*

Although most prioritization criteria were intended for application across all CW business areas, some criteria, such as Federal revenue generation, were applicable

only to one or two business areas. No efforts were made to validate the relative balance of the rankings between business areas.

### **3.2.5 Prioritizing Operation versus Maintenance**

Early in the LRD and SWD development efforts, the two Districts concluded independently that it was not possible to use the same rating criteria for both project operation and maintenance. Each District also decided that it was best to exclude baseline\* operations work packages from the prioritization process.

### **3.2.6 Prioritizing Repairs versus Studies or Mandated Activities**

In this context the term *studies* includes Lock and Dam (L&D) Major Rehabilitation studies, Dam Safety Assurance studies, updating standard procedures, scheduled periodic inspections, etc. The working groups for SWD and LRD had a very difficult time prioritizing studies versus repairs, and they did not include studies at all in their priority ranking criteria.

The working groups also had difficulty prioritizing other mandated activities, such as the placement of large signs warning boaters of a downstream wicket dam. Wicket dams are difficult to see from upstream, and boaters have been injured going over wicket dams of which they were unaware. The required warning signs are very large and expensive to install (i.e., approaching six figures).

Based on the proceedings of Division-level budget meetings, it appears that clearer guidance from Headquarters could solve some of these prioritization difficulties. District and Division managers are generally uncertain of how much money should be diverted from normal activities to fund mandated activities and improvements. These managers also wish to update standing operating procedures (SOPs) and other documentation, but the benefits of such efforts are not highly visible. Furthermore, it would be problematic to pay for this type of ‘intangible’ benefit by reducing O&M funding to an extent that could result in customer complaints. Also, participants in these O&M budget meetings were uncertain how much money should be committed to Major Rehabilitation and Dam Safety Assurance studies

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\* The term *baseline funding* refers to the recurring costs of a project. Everything that has been funded for the 5 previous years qualifies as a baseline operations activity.



even though these might result in obtaining significantly greater amounts of Construction, General (CG) funding.

### **3.2.7 Work Item Cost Justification**

Work package prioritization is not the only aspect of the O&M budget process where there is room for improvement. An accepted prioritization process assumes that an optimal funding level for each work package has already been determined. This in fact is generally not the case, as discussed previously, because O&M budgeting processes tend to be target-based while also susceptible to change due to external influences. In order to more objectively calculate optimal funding for individual work packages, then, a uniform, fact-based cost justification methodology would be valuable. In the work described here, however, alternative approaches and funding levels for work packages were not incorporated into the prioritization process, and only one criterion explicitly addresses repair costs in the rank ordering process.

One way to approach work package cost justification is to systematically review all projects and associated activities for both consistencies and anomalies. Studies such as those conducted within LRD and SAD could be extended to all business areas, including comparison of specific O&M activities on a project-by-project basis for inconsistencies. An example would be lawn mowing; for contracted mowing, standard requirements could be created for height, frequency, etc. Such standardizations would be used as a baseline for the purpose of avoiding wasteful inconsistencies; deviation from a standard would be authorized for clearly specified reasons when project-specific conditions warrant.

### **3.2.8 Budgeted Amounts versus Execution**

Each District budget is considered a plan — not a mandate — for how the money will be spent 2 years later. Once a District receives money, the O&M budget has little to no restriction on how the District actually spends its money. Without a more direct linkage between budgeted monies and actual expenditures, there is little incentive for Districts to minimize the budgeted cost of work packages. The current O&M budgeting methodology unintentionally creates an incentive for Districts to budget for unknown contingencies under the heading of an unrelated work package. Although these contingencies typically do in fact represent unforeseen, high-priority work that cannot be delayed until the next budgeting cycle, it seems clear that this practice distorts the concept of developing financial budgets for specific stated purposes.

A related problem is that, within a District, managers with specific areas of responsibility have little incentive to eliminate inefficiencies from baseline activities so long as continuing funding is available. Even though these managers work to optimize the money they receive, the execution does not necessarily represent the optimum use of these funds within the District. In times of increasingly restrictive budgets, the incentive is to maintain funding for even inefficient baseline activities in order to create a margin of financial safety against across-the-board cuts or static budgets.

### **3.3 Summary of Tool Development Efforts**

In addition to the SWD and LRD efforts previously noted, SAD and Northwestern Division (NWD) also have been developing tools to help prioritize O&M work packages, mainly repair work packages. Most of the ranking tools described here were based on the summation of 7 to 10 parameters weighted according to importance. Each parameter was scored according to descriptive criteria.

#### **3.3.1 SWD and LRD Prioritization Criteria**

SWD initiated its effort to create a budget prioritization tool during Fiscal Year (FY) 99. Although this preceded the first year of the O&M Management Tools program, ERDC/CERL personnel attended an SWD meeting on the subject. It was evident from the proceedings of this meeting that SWD could benefit from an objective tool that promoted collaboration by enabling the Districts to actually see the requirements and build a consensus on the ranking.

In FY00, LRD also began a parallel effort to develop a prioritization tool. In their first meeting, LRD personnel used the SWD criteria as a starting point and invited attendance and participation by SWD, ERDC/CERL, and the Institute for Water Resources (IWR). The result was a different set of ranking criteria that was similar to SWDs in application. Subsequent meetings on this topic by LRD and SWD were united into a joint effort. Meetings were held at each Division with a core group from LRD, SWD, ERDC/CERL, and IWR joined by additional participants from the Division hosting the particular meeting. The agenda of each meeting was to work on the prioritization tool for the host Division. Many of the process improvements developed for one Division were subsequently added to the ranking tool for the other Division, but the two tools never merged into single one.

In FY00 the two prioritization tools differed mainly in the following ways:

- The LRD descriptions for *low*, *moderate*, and *high* priority were more descriptive than SWDs.
- LRD has no “public relations” parameter.
- LRD commingled revenue generation, M&R cost reduction, and other benefits within an economic parameter, but SWD separated them.
- LRD’s “mission critical” and “customer impact” criteria increased in weight over time, and ultimately were assigned much more weight than SWD’s.

In FY01, the principal change made to each Division’s draft tools was to apply a matrix to each parameter that would enable the user to evaluate the consequences related to postponing a work package separately from the probability that the consequences would actually occur. For example, a deteriorated part may fail under normal load or various other conditions. The actual probability of failure can range from unlikely to near certainty, and the consequences failure may range from minor to catastrophic. The matrices significantly reduced ambiguity in the ranking criteria. A second FY01 improvement to the prioritization tools was the addition of more detailed application guidance, including illustrative examples of hypothetical work packages and explanation of how the criteria would be applied to develop a priority rating. The FY01 SWD and LRD prioritization criteria and matrices are presented in Appendices J and K, respectively.

### **3.3.2 CERL / IWR Alternative Prioritization Criteria**

An alternative set of prioritization parameters, proposed (but not tested) by ERDC/CERL and IWR, is presented in Appendix L. This effort was undertaken in FY00 to evaluate different parameters for inclusion in a prioritization process model. The most notable difference between these and the SWD / LRD criteria is that the mission and customer impact parameters were not explicitly addressed in the CERL / IWR version, but were instead captured under the heading of other criteria that consider economic benefits and meeting a minimum acceptable level of service.

### **3.3.3 SAD Prioritization Criteria**

SAD initiated their effort to create a budget prioritization tool during FY01. They are taking a significantly different approach from SWD and LRD. They are developing prioritization criteria for each business area, which removes the difficulty of weighting the relative importance of the business areas. Working within a business area, all packages can be compared based on their contribution to the business area objectives. This method also allows the business area working groups to be organ-

ized across Districts, focusing on one part of the Division's total budget. Business area groups tend to be more able to communicate necessary detail of the needed work for the group to evaluate the priority. The difficulty is that once all the work packages are prioritized within the business area, a method must be applied to integrate the rankings for all business areas. SAD participants saw a benefit in the efforts but had only achieved a small part of their objectives in FY01 and intended to continue their efforts in FY02. The SAD prioritization criteria for the Navigation, Hydropower, Flood Control, and Environmental Stewardship business areas are attached to this report in Appendix M.

#### **3.3.4 *Mississippi Valley Division (MVD)***

In FY00 MVD initiated plans to validate the baseline work and develop criteria for improved validation of baseline tasks. The Budget EC (EC-11-2-183) includes criteria for work becoming baseline but does not address the importance of the work nor does it suggest when the work is no longer needed and the work package can be dropped to free funds for other work packages. As of last contact in FY01, MVD had not completed this task.

#### **3.3.5 *Hydropower***

USACE and BPA developed priority ranking criteria for hydropower capital investment, which is included as Appendix D of this report. The methodology used is very similar to the LRD and SWD prioritization tools. It is slightly more complicated and the parameters may necessitate more data and calculation. The criteria are less ambiguous, but this is due in part to the advantage of including repairs and improvements in only one business area.

#### **3.3.6 *NWD Relative Risk Ranking Guidelines for Non-recurring Dam Safety Issues***

The NWD Dam Safety repair ranking criteria are attached to this report in Appendix E. This may be the best ranking tool of those reviewed in this study. This is in part because it is focused on a much smaller group of budget items (dams safety repairs only). Regardless, the strategies used to guide the evaluation and ranking process are simple and should be adequate to prioritize the work. A similar process could almost certainly be developed for most other types of work packages, but it would be difficult to compare the results of the existing tool to those for any other type of work package.

### **3.3.7 O&M Cost Savings Report (April 1997) – The “Tisdale Report”**

This report was focused on determining whether the expenditures on a given project were comparable to other Corps’ projects. It is unclear why they used the metrics the way they did, but there is some good information within the data they collected and many of the metrics could be used within a work package prioritization tool.

### **3.3.8 Conclusions on the Relative Ranking Procedures**

The ranking tools helped the people creating and ranking the work packages make more informed justifications and decisions, which is a very valuable benefit that should be further developed. It could also be a means by which USACE Headquarters can better communicate its priorities to the Districts and Divisions. In the opinion of the authors, the ranking scores resulting from the processes were not as valuable as performing the process, particularly for the SWD and LRD tools, which had to compare dissimilar work from different business areas. Generally, the criteria did not capture in sufficient detail the specific reasons for completing the work.

## **3.4 FY02 O&M Budget Process**

The Budget EC (EC-11-2-183) included major changes in the way the District budgets should be formulated. Prior to FY02, the work packages were grouped in four levels: Baseline, Non-Deferrable, Deferrable, and Maintenance and Repair Beyond Ability (MRBA). In the current Budget EC, the number of levels has been reduced to two: Non-Deferrable and Deferrable.

When the four levels were originally created, most Districts could fund all of their Level 1 and Level 2 work packages and many in Level 3. The Level 3 Deferrable work packages were addressed based on priority, and work proceeded as funding allowed. Level 4 MRBA was work that the District truly did not want to budget for in the program year. It included work that they were not ready to complete (incomplete plans or inadequate resources) and work that they might expect to need after the program year for which they wanted to document the need.

Recently, no District has been programming funding for Level 3 budget items. In fact, some Districts have been struggling to fund Level 1 budget items. In this reality, it makes no sense to distinguish between Deferrable and MRBA since neither will be funded. Although it may be problematic to label work not being done as

“non-Deferrable,” it is also a valuable measure of funding shortfall that is called “Critical Backlog.”

Although it is possible that elimination of two budget funding levels may have negative consequences (such as increased labor to prioritize the baseline work packages) in addition to the difficulties inherent to implementing any change, the modification clearly has advantages. It primarily eliminates the artificial separation between recurring activities in the funding baseline and non-deferrable work not performed on a yearly basis. Historically, Districts saw an advantage to getting work packages recategorized to baseline at the largest dollar value possible. Unfortunately, the work packages qualifying for baseline designation were not always the most important work, so the designation distorted the budget process and led to a suboptimal budget.

## 4 O&M Handbook

Corps R&D laboratories have produced hundreds of valuable, cost-saving technical documents, software packages, assessment procedures, etc. Due to practical limitations on communication, information about these products fails to reach many intended end users on a timely basis.

The objective of this work was to provide to the Civil Works O&M community a database of new and readily available technologies that produce cost savings or other benefits that have proven successful but have not been widely used by the Corps. This web site puts a searchable catalog of valuable resources at the fingertips of all users at the project, Division, District, and Headquarters levels. The database can be found at: <http://www.cecer.army.mil/pl/omhandbook/>

The web site contains the “Civil Works O&M Handbook of Best Practices,” more simply referred to as “The O&M Handbook.” It is a catalog of beneficial technologies that have been developed, tested, and demonstrated but have not yet been widely adopted in Corps operations. Each technology has been verified to provide one or more of the following benefits:

- Compliance with Cultural Resource Laws
- Compliance with Environmental Laws
- Cost Savings
- Extended Project Life
- Improved Fishery and/or Wildlife Habitat
- Improved Flood Control Capabilities
- Improved Navigation Conditions
- Improved Operational Capabilities
- Improved Project Reliability
- Improved Safety
- Improved Water Quality
- More and/or Better Information to Support Management Decisions
- Reduced Life-Cycle Costs
- Reduced Manpower Requirements.

Entries are sent to the Webmaster ([David.T.McKay@erdc.usace.army.mil](mailto:David.T.McKay@erdc.usace.army.mil)), who uploads the entry after an editorial scrub for quality control. The original author for each entry has password-access enabling him/her to update the information. Each catalog entry includes a textual description of the technology, a graphic or photograph, Points of Contact (POCs) with e-mail addresses as well as interactive features allowing users to contribute comments, read other users' comments, or get in touch with a technical POC for more information. Each entry also includes web-enabled hyperlinks to related information resources such as web sites, technical reports, official criteria documents, etc. Another feature of the database is a report that lists the comparative benefits between technologies. When a search produces five or fewer technologies, a report citing the benefits of each can be generated. As of July 2002, the catalog included 156 beneficial O&M technologies. The site is active but has never been advertised to the Corps due to the curbing of funds for the O&M Tools program. Approximately 20 new technologies, or updates to existing entries, could be expected per year, costing an estimated \$15,000 per year to maintain the database.

While initiating the O&M Handbook project, the question of software approvals was raised. Specifically, meeting Life Cycle Management of Automated Information Systems (LCMIS) requirements was a potential obstacle to developing and fielding a product. However, because development costs were well under \$500,000 (actual to date is \$196,000) and life-cycle maintenance of this web site is well under \$1M (estimated cost of \$15,000 to \$20,000 per year), it is free of LCMIS red tape per ER 25-1-2. In addition, all information technology expenditures are tracked by the Information Technology Portfolio System (ITIPS), which receives its data from the Corps of Engineers Financial Management System (CEFMS). A sample entry follows on the next page.



## **Foundations and Earth Structures/Coastal and Hydraulic Structures/ Recreation and Natural Resources**

**Cost-Effective Shoreline Erosion Control.** Shoreline erosion often threatens critical resources and real property at Corps of Engineers (COE) reservoirs, many of which are eroding at alarming rates. At least 60 percent of COE reservoir shorelines are threatened with erosion, and more than 10,000 COE reservoir miles are estimated to have moderate to serious erosion. Conventional structural approaches to erosion control (e.g., revetted riprap or bulkheads) are expensive, not always necessary, and sometimes not compatible with environmental objectives.



**A low-cost, biodegradable, floating breakwater being installed to protect flood-tolerant vegetation planted on the shoreline until it is established.**

New cost-effective concepts for reservoir shoreline erosion control were investigated and demonstrated. Guidance was developed for selecting, designing, and constructing biotechnical and low-cost structural erosion control at reservoirs.

An example of the application of this technology was its use on 1000 ft of shoreline at Eufaula Lake, OK. The application was a success and the cost was about 1/5 that of traditional riprap protection. The resulting cost savings were \$200,000.

**(Technical Notes: GT-SE-1.5 and GT-SE-1.6)**

**Web Site:** <http://www.wes.army.mil/REMR/remr.html>

**(Technical Notes: MI-01, MI-02, MI-03, and MI-06)**

**Web Site:** <http://www.wes.army.mil/el/elpubs/wqtncont.html>

**(WOTS Information Exchange Bulletin, Vol. 1, Issue No. 1, July 1999)**

**Web Site:** <http://www.wes.army.mil/el/elpubs/wqbulletin.html>

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**Keywords:** erosion, shoreline, reservoir

**Technology Benefits:** Cost Savings, Improved Fishery/Wildlife Habitat, Extended Project Life

## **5 Field Advisory Workshop (May 2001, St. Louis, MO)**

### **5.1 Background**

Before the start of the O&M Tools program, from 1998 through 2000, several preliminary planning meetings took place. During the course of the program from 2000 through 2002, annual meetings were conducted before an FRG, which served in the capacity of an In Progress Review (IPR) panel, and which also served to plan and/or recommend redirection of research emphasis. All of the FRG meetings were attended by the Corps sponsors (CECW-O), at least one representative from the Corps Directorate of Research & Development (CERD), and various personnel from the field who functioned at the Division, District, and/or Project levels. Decisions were based on a show of hands (and the R&D team had no vote). The annual FRG meetings were attended by roughly a dozen people excluding the R&D personnel and lasted a total of 8 to 10 hours.

### **5.2 Problems With the Program**

The research team had a dilemma because the CI work units were designed to be mutually supportive, where results from one research emphasis would complement and reinforce that of another. The FRG meetings resulted in substantial shifts in research emphasis that greatly hindered planning and progress within and across work units.

In addition there were unresolved questions and some confusion about who would be using the products and under what circumstances. At one time USACE mandated that CIs be part of the budget development process. In part, Headquarters hoped the mandate would lead to better-informed decisions within the Districts, but the mandate did not explain how Districts should use the information to prioritize their budgets, and it was plainly evident that Headquarters did not use the data when reviewing budget submissions. Compounding this problem was the fact that the reporting requirement was not consistent with the way in which CI data are col-

lected. The mandate resulted in negative impressions of CIs since the logic of the mandate was not communicated.

At this point in the program it was apparent that fundamental issues were still up in the air. Should CI usage be required at the District level or Division? Would HQUSACE even see any of the data? In what form? For what purpose? In retrospect the research team should have been much more proactive in addressing such issues early on; however, the O&M Tools program itself was, in fact, an attempt to re-introduce the CIs corporately. From the birth of the concept in the early 1980s up to the present day, the issues of CI systems and how they should be used was and is a controversial issue with both supporters and detractors.

At each of the FRG meetings the relative priorities for the work units was decided by borderline voting (see next section) that resulted in “flip flopped” priorities after each FRG meeting. One research emphasis on the subject of Summary Indexes (SIs) was dropped altogether. This apparent discontinuity in thought has a couple of explanations:

- The research team failed to focus on the general principles and customer needs being addressed. Instead the R&D team dwelled on detailing technical accomplishments; in effect they were anxious to demonstrate their technical accomplishments and to prove that the funds were being well spent. Unfortunately the “death by PowerPoint” barrage was more effective in putting the panel to sleep.
- In the last FRG meeting, the research team wanted technical input at a level of detail that the FRG members were either unwilling or unable to provide.
- For a variety of reasons, a significant number of familiar faces were absent at each meeting, only to be replaced by an equal number of unfamiliar faces. The result of this particular problem was that many of the fundamental concepts and products upon which the R&D was founded needed to be re-explained. This led to an ineffective use of time and uninformed voting. In addition to the loss of institutional knowledge, the new FRG members also had independent viewpoints and priorities.

### 5.3 Field Advisory Workshop

The borderline voting by the FRG discussed above was truly that. A persuasive personality could easily have swung the voting to one side or another. This indecision resulted from the fact that the research team failed to reconvince the FRG that the field would benefit from and indeed wanted the products that were being developed by the O&M Tools program. The indecision was seen as a vote of no-confidence by the R&D team. Therefore, a workshop was planned, convening people who work in O&M in the hopes that an outside voice might bring a stronger sense of conviction that what was being tried either made sense or did not.

In addition to the objective of the workshop, Chief of Operations (CEMVP) was tasked by Chief of Operations (CECW) to prepare and deliver a briefing to him regarding the potential for CIs and similar products that could result from the O&M Tools program.

Appendix N contains the minutes for this meeting. Highlights of the meeting and the recommendations resulting from it are listed below.

The meeting lasted 2 days with the group generally backing the initiatives as indicated below. The Chiefs of Operation met, and, although there is no record of the meeting, it would appear that no decisions resulted from it since no overt changes in HQUSACE policy on CI have been made. (The use of CIs remains optional.) An additional two products were proposed by the group: an [Infrastructure Health Report Card](#) and [O&M Data Integration](#).

It is worth noting that the [minutes](#) documenting this meeting describe well the current state of the O&M Tools products and recommend well thought out direction for future emphasis.

#### 5.3.1 Simplified Condition Indexes

A point that was repeatedly made during the meeting was that the *process* of determining CIs, priorities, relative needs, etc. are just as important as the end result. The processes do not replace human judgment and never should; they support decisions and should be used to convince others that the right decision has been made. The *processes* demonstrate that discipline was used to arrive at a decision, which makes the decision more believable and convincing. It was generally agreed that, within any implementation plan, the processes should be open to everybody with equal access.

The Field Advisory Board (FAB) thought the effort to simplify the process of collecting condition data and generating indexes should continue. The group recognized that the CI procedures as they are used today help some, but not all, organizations. Today, use of CI systems is voluntary but at one time they were part of the Budget EC. Because of ambiguities between the EC and the ABS reporting system, the CI was dropped as a budget reporting requirement. It was evident that HQ was not looking at the information seriously; however, it was noted that the process alone provides a degree of consistency and open communication. As practiced today, most benefits are realized at the Project and District levels. Ideally, however, the greatest benefit can be realized when the CIs are used not only at all levels, but with a consistent process and policy for usage and reporting that does not exist.

In spite of a clear dislike by District personnel for mandates from higher authority, they clearly agreed during the workshop that a consistently applied process for use of CIs would be valuable.

### **5.3.2 The O&M Handbook Web Site**

The O&M Handbook was soundly deemed to be a useful and worthy product that should be made known Corps-wide and supported for the long term; a lessons-learned module should be added. It was recommended that all USACE O&M home pages contain a hyperlink to it.

*Note: The web site was never officially announced. It is now unfunded and its fate is uncertain.*

### **5.3.3 Prioritization**

An argument was put forth that the R&D on the prioritization work was completed since successes were realized in SWD and LRD. This opinion came from outside the budget prioritization working groups for each Division. It would be fair to say those groups felt they had made progress but did not think they had reached a workable solution. In any case, the final recommendations from the FAB indicated that the group was in favor of seeing more from this line of investigation because: (a) it provides a process to uniformly prioritize work, (b) helps the MSCs assure they are putting money in the right places, (c) the research has potential to lead to more powerful products.

An effort to develop budget prioritization metrics was initiated in FY01 in SAD. They took a different approach than had SWD and LRD and were looking at ways to prioritize work within business functions. The FAB discussed the approaches with no cogent resolution. A summary metric of some kind may be useful in addressing this dilemma.

#### **5.3.4 Benefits Analysis**

Benefits analysis was discussed as a more specific form of prioritization, but no conclusions were reached.

#### **5.3.5 Reliability and CIs**

A U.S. Military Academy representative presented the results of work he recently completed that considered relationships between the CI and reliability analysis. His immediate focus was on whether CIs could be used to upgrade existing deterioration models for corrosion or fatigue. He considered a sample problem of corrosion on a miter gate. His conclusion, simply, is that, although the current design for corrosion-type CIs does not accommodate Reliability, with a little bit of modification it could. In addition, as the reliability analyses become more sophisticated, the associated roles for CIs will become greater, and a potential exists to use CI data to update fatigue deterioration models.

The USMA representative recommended that designers of CI systems talk with reliability experts in order to improve the CI's ability to complement reliability analyses, and to focus especially on how CI data can be used to quantify conditions in probabilistic terms (e.g., frequency of data collection in order to quantify a transition state). He further recommended HQUSACE oversight for funding a more formalized program for development, training, and periodic mandatory use.

#### **5.3.6 O&M Data Integration: One Time Data Entry**

The frustration of having to enter duplicate data in multiple places was clearly expressed. This frustration arises from all aspects of the O&M program, not just the CW Mgmt Tools products. Every effort should be made across all of the O&M program to centralize data entry, and any single piece of data should be entered once and only once. The advent of Facilities and Equipment Maintenance System (FEMS) may go some distance toward alleviating this concern.

The software for CIs is now outdated; most of it is in DOS format and it is not known how long this Operating System will remain compatible. Storage and reporting requirements for CIs could be handled by FEMS.

### **5.3.7 Summary Indexes**

The SI concept arose as part of an earlier R&D Operations-funded program that produced a product called QUADRANT. It was designed to function as a black box which received as input a description of current condition levels, repair cost, and the expected condition level after the repair; the output was intended to be benefits-associated with the repair expressed in dollars. In this manner different repair schema could be compared and an optimal selection might be made.

There were inherent problems, beginning with the description of condition levels for input. Such input seemed possible within the context of CI type data, but there was no standard set to transform the CI data into something that the QUADRANT tool could use. This did however give rise to much discussion about the concept of an SI. What exactly an SI was and how it was supposed to be used became a contentious issue in some circles. Nothing was ever decided formally, but what appears below is a formulation (or proposal) of the SI in terms looked at by the O&M Tools R&D team.

One very important outcome from the discussion about SIs was the concept of the [Infrastructure Health Report Card](#) described under the next heading.

#### **ERDC Proposal For a Summary Index (SI)**

- **Problem:** The Corps of Engineers cannot adequately quantify and communicate the condition, readiness, and effectiveness of its Civil Works Infrastructure. Also, the Corps' budget is based on historical spending levels but there is no measure of the effectiveness of O&M expenditures and the Corps does not have adequate information to determine the optimum budget level. To address these deficiencies, the Operations and Maintenance (O&M) community needs a tool to quantify the overall condition for a project site and track changes in condition over time.
- **Objectives:** The objective of this work unit is to provide a methodology to quantify the condition of a project site. The summary index will correlate to the needed maintenance and repair. A second objective will be

to develop a composite index. The composite index will be a methodology for combining or dividing component CIs in order to rate the condition of the specific infrastructure being repaired within a work package.

- **Description:** Work will proceed toward a product with a technical rigor and precision somewhere between two extremes. The extremes are as follow:
  1. Develop a summary index that is heavily dependent on component condition indexes. Most of these condition indexes have been developed but the summary index would require additional indexes. As the extreme, this would be totally compatible with a composite index. This method would have significant cost and effort and would not be cost effective unless the information was also used for other reasons.
  2. The other extreme would be to develop a highly subjective set of condition categories. At this extreme, the rating would be similar to the Installation Status Report (ISR) developed by Army Chief of Staff for Installation Management (ACSIM) and West Point. This method would be easy to use and require minimal effort but may have severely limited accuracy and would not have other applications beyond being a network condition quantification.

The primary task in the first year will be to arrive at a decision point regarding the general content and methodology for both summary and composite ratings. The basic question to be answered is how to optimize the inspection, data collection and quantification efforts with the benefits to be obtained from the indexes. The answer will depend on the benefits of the summary index itself, the way composite indexes will be used for work package justification, and the other uses of CIs as inspection and condition quantification tools, such as investigating problems and benchmarking condition. The preferred composite and summary index approaches will also depend on work on CI simplification and a work package prioritization scheme, each which may be largely undetermined in the first year. The first year decision will determine the following year milestones. ISR-type summary indexes can be completed for inland navigation, coastal navigation, flood control, hydropower and recreation under the proposed funding. It is unlikely that those five summary indexes can be developed under the funding and time constraints using condition indexes as the primary basis. The work unit would therefore initially focus on one or two summary indexes.

- **Benefit:** Use of this product will allow the Corps to quantify the condition of its infrastructure. Trends in average condition can be analyzed to help de-



termine the adequacy and effectiveness of maintenance and repair expenditures.

- **Accomplishments:** This work was never funded.
- **Milestones:**

Title	Scheduled	Rescheduled	Completed
Decision point for Summary Index approach	Aug-00		
Composite index for inland navigation	Jun-01		
Demonstration for Proponent	Jul-01		
Composite indexes for flood control and hydropower	Nov-01		
Summary index for inland navigation	Jun-02		
Demonstration for Proponent	Jul-02		
Summary index for hydropower	Aug-02		
Summary index for flood control	Sep-02		

• <b>FUNDING:</b>	Type	FY00	FY01	FY02	Total
	In house	50k	150k	80k	280k
	<u>Contract</u>	<u>0</u>	<u>50k</u>	<u>20k</u>	<u>70k</u>
	Total	50k	250k	100k	<b>350k</b>

### 5.3.8 Infrastructure Health Report Card

The concept of an encompassing metric (something akin to an SI) fueled an enthusiastic and lengthy discussion of the concept of an “Infrastructure Health Report Card.” The group saw value in developing a metric similar to the American Society of Civil Engineer’s (ASCE’s) annual report card on the health of the nation’s infrastructure. The FAB determined the following:

- The Infrastructure Health Report Card should be a simplified grading system the public can easily understand, such as A, B, C, D, or F. There should be a pass-fail point in the grading system. The Infrastructure Health Report Card could have subcomponents broken out according to business function (e.g., Navigation, Flood Control, Hydropower, Environmental Restoration, Recreation, Water Supply). An SI type of metric should be developed at the Project level. The Infrastructure Health Report Card results from a roll-up of the Project level metric and relates a simple status of readiness that is relevant to customers and can reflect physical state of facilities, expected levels of service,

and/or reliability information. Customers and stakeholders might use such a Report Card as an inspiration to write letters to their congressman. The Infrastructure Health Report Card could even go so far as to give HQUSACE something to defend its budget requests to the administration, OMB and Congress.

- The Infrastructure Health Report Card should only reflect a current status or readiness. No attempt to directly or explicitly bind the Report Card grades to the budget should be considered. It should not be used as a prioritization tool nor as a tool for funds allocation. Instead, impacts of budget shortfalls might be compared to the SI, CIs, or other metrics derived from the CI and prioritization work units.
- The grades should be based on factual information or data that are measurable. Results should be repeatable and independent of who performs the evaluation. Any system developed should make maximum use of existing information such as periodic inspections, CIs, dam safety inspections, quality assurance inspections, maintenance data, and the like. The grades should cull input from environmental concerns, customer surveys, and more. The validity of the rating can be established by comparing it to other readily available information.
- The U.S. Army Engineer Research and Development Center (ERDC) should be doing the developmental work but there should be a Process Action Team (PAT) to oversee the development, progress, and presentation of the product. A review of what standards (if any) that are being used by other agencies along these lines must be considered (e.g., ASCE, Tennessee Valley Authority [TVA], Bureau of Reclamations [BUREC], NPS). These same groups could provide peer review of the final product.
- The Infrastructure Health Report Card must be compatible with ongoing efforts with the USACE such as the rating of projects as done within the Project Management Business Plan (PMBP). Master plans for operations, safety, health, etc. should be considered.
- The Infrastructure Health Report Card should be assessed at least annually so that the result is believable as a real-time assessment. Simplicity must be stressed, a simple matrix format should be considered for deriving or calculating the Infrastructure Health Report Card. For the Districts to buy into the process, HQUSACE (or the oversight committee) must provide fair and equitable policing and regulation. The Infrastructure Health Report Card should be incorporated into the Chief's and each Division Commander's annual status report to the Congress. A rapid implementation of this product is recommended.

## 6 Conclusions

CIIs have demonstrated potential as a cost saving tool but, after many years of inconsistent application, it remains difficult to calculate a return on investment from using them. It is difficult, therefore, to argue for continued development because the greatest value of CIIs are realized when *everyone* uses them consistently. This may be asking too much. Changes in leadership and personnel coupled with the current complexity of the systems will probably prevent this from ever happening. However, the use of CII systems remains voluntary and there are Districts still using the CIIs because of the benefit realized locally.

[Simplified CIIs](#) developed for miter gates and tainter gates can yield time savings of 75 percent and might prove to be even more useful than the original CII procedures but they were never given the chance to be demonstrated. The time required for simplified inspection of concrete in lockwall monoliths can be reduced so much that an entire lock and dam can be inspected and rated in 2 hours. New ways of collecting data should be developed with attention paid to making the data compatible with the Infrastructure Health Report Card.

Developing a series of inspections whose level of detailed scrutiny ([Multi-Level Intensity Inspections](#)) is matched to the requirement being met is a concept that can be utilized whether CIIs are used or not. Such inspections should be consistently used Corps-wide. All data that would be collected should be simple, accessible, repeatable, open to scrutiny, and have the capacity to serve as input for the Infrastructure Health Report Card. It is recommended that the MLI procedures be incorporated into Engineer Regulation (ER) 1110-2-100 for Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures.

The [O&M Handbook](#) is a good idea gone to waste. Never has there been a more vocal and positive support for a product that this team has encountered. It is recommended that this product be implemented and supported. It can receive 20 brand new entries per year, multiple updates, and be administrated for \$20,000 per year to start and \$10,000 per year once the activities involved settle into a routine.

The [prioritization](#) work showed practical results in the LRD and SWD organizations. However, the problem of prioritizing across business function still remains unsolved. The work should continue with the objective of creating a generic framework for other divisions to follow. Efforts in this work unit may also provide useful routines for assessing potential benefits obtainable by proposed changes in condition and/or performance resulting from an O&M investment.

A rapid implementation of the [Infrastructure Health Report Card](#) is recommended. The product is similar to the ASCE report card on the health of the nation's highways, bridges, waterways, etc. The report card should have grades A, B, C, D, E, or F assigned to all of the routine Civil Works business functions. The report card should be based on available data, accessible by anyone, derived once a year, given overview by an independent committee perhaps involving other Federal or public agencies and be endorsed by the Chief of Engineers. The product will represent current condition and operability states and not be connected to the budget in any way or circumstance. Its uses would be many.

Despite efforts like Operations Management Business Information Link (OMBIL), which is supposed to centralize data input, many systems within OMBIL still require duplicative data. Also, there are additional unlinked systems, including new and emerging systems such as the CIs, FEMS, Dam Safety Program Management Tools (DSPMT), and others that ultimately force duplicative data entry into multiple systems. A piece of data should be entered once and only once.

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## Appendix A: CI Simplification for Horizontally Framed Miter Gate

*Lock & Dam Investigations, Inc., Ames, IA, July 2001*  
*David T. McKay and Stuart D. Foltz, ERDC/CERL, 2002*

Proposed simplifications of observations, data readings, and recordings for condition index inspection and evaluation of distress components:

### Anchorage System

<u>Horizontally framed gate</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
Location #1	0.030 unless flexible	similar to existing procedure	na
Location #2	$(0.25 * W/H)$	new Yes/No questions, revised CI calc	1/8 in. or >
Location #3	$(0.18 * W/H)$	new procedure & $X_{max} = (0.025 * W/H)$	$(0.015 * W/H)$

Location #1(at concrete embedment) – Only a minor change from the existing procedure is proposed. Dial gauge readings would be recorded when the miter gate is mitered with full head of water load, at a new position called off-miter (gate just broken from mitered position), and in recess position. These readings will yield an observation of the full extension/compression of both anchor arms.

A simplified CI is calculated in the same manner as the existing procedure.

Location #2 (at the linkage bar) – The proposed procedure is similar to the existing procedure. The linkage bar may be configured in several ways including turn-buckles, wedge plate assemblies and connecting pins. The existing CI is determined by the total change in length of the anchor arm, across all linkage pieces. Various ways of observing and recording this total change have been used, but the simplest and most useful has been to record data at each individual linkage interface and sum the individual changes.

In the proposed simplified procedure, at each interface where movement could occur, the question of movement would be asked and quantified by a simple Yes/No query:

Is there evidence of movement? Y / N, and then how much?  $<1/16$ ,  $1/16$ ,  $1/8$ ,  $1/4$ ,  $>1/4$

The observation of each interface would cover the full range of gate operation, from mitered to recessed. An inspector may use a setup of dial gauges to help in this determination but it would not be required.

A simplified CI could be calculated by summing the values returned for each interface query, then evaluating the total value versus the existing Xmax for Location 2, (0.25 inches \*W/H). The simplified CI would be defined as a max of CI = 85 if all queries were answered “No” on the question of movement, and a max of CI = 70 if any of the answers were “Yes” on the question of movement.

The trigger concept means that IF the #2 reading is recorded as  $1/8$  or greater, THEN the recommendation would be to use the existing methods to get greater accuracy of measurements.

Location #3 (at the gudgeon pin) – The proposed change to the inspection procedure is significantly different from the existing procedure. However, it provides the ability to observe movement of the gate assembly at points in the gate operation cycle when the most likely reason for this movement is due to wear (and hence a gap) within the gudgeon pin/bushing connection. The proposed change would observe the movement of the gate frame relative to the wall at two unique gate positions during the gate operation cycle. The first gate position starts with the gate mitered and under full head pressure from the normal pool levels. Several dial gauge readings are taken from full head and as the head pressure is removed and the gate broken off miter by “bumping” the operating equipment (OE). This change in relative position (to the wall and the parallel anchorage arm) is nearly instantaneous but can be quantified by observing dial gauge readings and indicator needle behavior. The second gate position is when the gate is initially being pushed away from the recess position against the wall. Again, this change in relative position (to the wall and the perpendicular anchorage arm) is nearly instantaneous but can be quantified by observing dial gauge readings and indicator needle behavior.

At Location #3 this new simplified concept would use simple apparatus and dial gauge devices set up on the grating above both perpendicular and parallel anchor arms. A preliminary setup of devices when the miter gate is in the mitered position is shown in the following photos:

### Parallel Anchor Arm



*The dial gauge is attached to a cantilevered angle secured to the grating installed over the anchor pit. The dial gauge spindle bears against the side of the vertical leg on the angle setting on the gate grating. The angle and dial gauge are aligned on the axis of the parallel anchor arm. In many instances, the grating on the gate frame fills the gap and the dial gauge may be placed directly on the grating similar to the second photo.*

### Perpendicular Anchor Arm



*The dial gauge is placed directly on the grating installed over the anchor pit, and the spindle bears against the side of the vertical leg on the angle that setting on the gate grating. The angle and the dial gauge are aligned on the axis of the perpendicular anchor arm.*

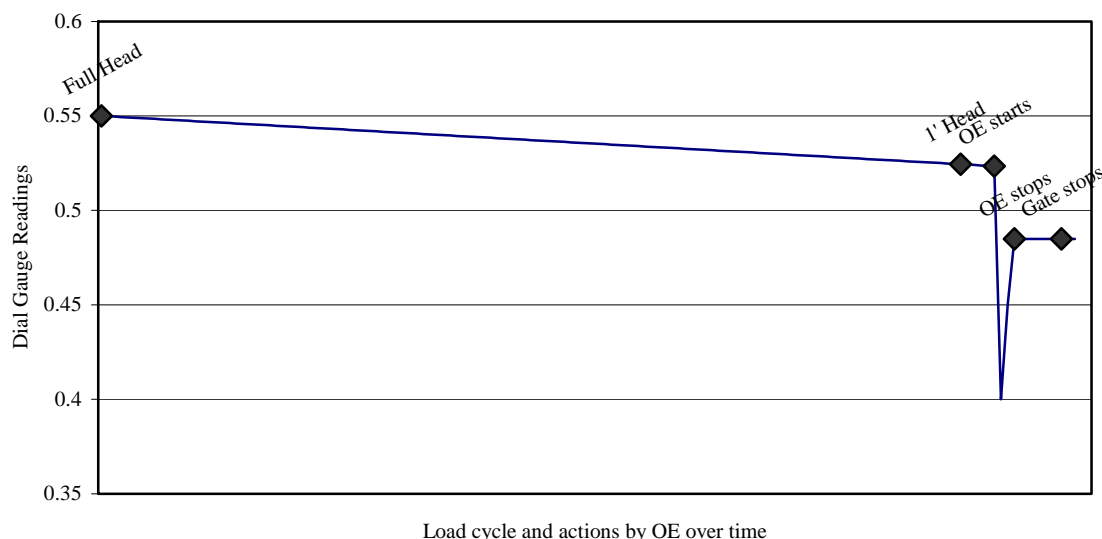
In the proposed simplified procedure, the principal observation readings would be taken when the OE pulls the miter gate off of the mitered condition. An initial dial gauge reading of the dial gauges set up over both anchor arms would be taken with the gate mitered and under full load. The dial gauges would then be observed during the operation time that the miter gate is unloaded (i.e., the lock chamber pool raised or lowered to equalize water levels). A dial gauge reading would be recorded at approximately 1-ft head to track the change due to head pressure. As the chamber pool is leveled with the respective pool, the gate may drift open slightly due to overfill (or emptying) of the chamber. Then, the OE would be operated briefly, commonly called “bumped,” to break the gate seal off the quoin wall and miter point. When the gate breaks off seal, the OE pulls the quoin end of the gate upstream and off the quoin block, using up any gap that may exist in the pin/bushing interface. This movement is captured by the dial gauge over the parallel arm with a rapid needle spin and spike point. The maximum spike reading on the parallel arm would be estimated and recorded. The OE will finally begin to pull the miter end of

the gate around and the parallel arm dial gauge will back off its maximum reading. When the gate movement has stopped from this initial bump by the OE, the third dial gauge reading of both parallel and perpendicular arms is taken and recorded. The maximum differential of the three fixed readings and the estimated reading of the spike point will be used to calculate a CI for the off-miter movement.

The chart below illustrates the time line and spike pattern of the dial gauge readings an inspector might observe. The time elapsed from Full Head to 1-ft Head and finally to OE starts may be minutes, and only a very small change in the dial gauge readings might be observed. The time elapsed from OE-starts to OE-stops is a few seconds. The spike occurs in a fraction of a second but is easily observed and estimated after just a few trial runs.

The second observation reading would be made as the miter gate is pushed away from the recessed position against the wall. A second apparatus setup of vertical angle and dial gauge similar to the second photo above would be used to capture the movement as the OE is used to bump the gate away from the wall. This setup is

Example of tracking of readings at parallel anchorage arm of miter gate



only over the perpendicular arm. The first dial gauge reading is recorded as the miter gate is held in the recessed position. As the gate is pushed out of the recessed position, the OE initially pushes the quoin end of the gate out towards the lock chamber before the miter point starts to move, using up any gap that may exist in the pin/bushing interface. This movement is captured by the dial gauge over the perpendicular arm with a rapid needle spin and spike point. The maximum spike

reading would be estimated and recorded. The OE will finally begin to push the miter end of the gate around and the perpendicular arm dial gauge will back off its maximum reading. When the gate movement has stopped from this initial bump by the OE, the second dial gauge reading of the perpendicular arm is taken and recorded. The maximum differential of the two fixed readings and the estimated reading of the spike point will be used to calculate a CI for the off-recess movement.

A simplified CI for Location #3 could be calculated for both gate positions using the dial gauge readings collected and evaluating them versus a new modified Xmax. The current value of Xmax at Location #3 is determined by the rule  $(0.180 \text{ inches} * W/H \text{ ratio})$ , which can yield an actual Xmax of 0.090 inches for a 1/2 ratio or 0.360 for a 2/1 ratio. A review of data collected on approximately 25 inspections conducted by Lock & Dam Investigation, Inc. (LDI) in recent years suggests that using a simple modification factor applied to the existing Xmax rule will correlate reasonably well to existing condition index values. On horizontally framed gates in the study, 24 gate leaves were included with W/H ratios ranging from 2.58 down to 0.48. Sixteen of the 24 gates fit the data correlation well, falling within the limits of acceptable range, including five of six gates with a W/H ratio below 1.0. Adding a modification factor to the rule changes the range of the calculated Xmax but not the concept. A more thorough discussion of the data and application of the modification factor will be included in the report. A final value for this modification factor will be determined in concert with field-testing and discussion with USACE personnel. A new preliminary modified Xmax value (derived by application of the factor to the rule) is set as  $(0.025 * W/H)$ .

The calculation of the aggregate CI for Anchorage Systems is not changed; it will still be the minimum of the component CIs in the system.

The trigger concept means that IF the #3 reading is greater than  $0.015 * W/H$ , THEN the recommendation would be to use the existing methods to get greater accuracy of measurements.

### **Elevation Change**

Horizontally Framed Gate	Current Xmax	Proposed Simplified Xmax	Trigger
Elev. change – miter	0.08 (W/H)	Eliminate Measurements and set CI = 85	See trigger rule
Elev. change – quoin	0.05 ft	Eliminate Measurements	See trigger rule

and set CI = 85

Elevation change is simplified by eliminating miter point and quoin elevation measurements unless other factors noted in the trigger are present.

The simplified CI is defined as 85 unless normal elevation measurements are taken.

The trigger concept for Elevation Change has several criteria that must be met individually:

-IF continuous miter bearing blocks faces are not nominally parallel (plus or minus 1/2 in.) throughout the exposed height of the miter blocks when the gates are mitered but do not have water load, THEN normal elevation data should be taken; or

-IF the miter offset of the continuous miter bearing blocks is angular (x-crossing of the blocks within the exposed height and more than 1 in. maximum offset either upstream or downstream), THEN normal elevation data should be taken; or

-IF diagonals flap is recorded as Yes in NJV, THEN normal elevation data should be taken; or

-IF a jumping movement or grinding noise is recorded as Yes in NJV and it occurs as the gate quoin block makes contact with the wall quoin block at final closure of the gate to miter position, THEN normal elevation data should be taken; or

-IF anchorage #3 is triggered, THEN normal elevation data should be taken.

### **Miter Offset**

Horizontally framed gate	Current Xmax	Proposed Simplified Xmax	Trigger
Miter Offset	0.25*(Block width)	No change proposed	na

Miter Offset will use the same inspection methods and evaluation of CI but is simplified by visually observing and estimating the miter block offset condition at the top and the DSWL (no climbing, boat, or tape measure required). The simplified procedure also requires recording which gate block is downstream with respect to the other gate block.

An additional observation of the angular contact offset is required to sort out if elevation measurements must be taken. This will be done with a simple Yes/No question but it will not be used in a CI calculation.

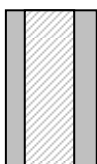
A simplified CI is calculated by evaluating the value returned by the estimate of the offset versus the existing Xmax rules for miter offset.

### **Bearing Gaps**

<u>Horizontally Framed Gate</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
Miter Gap	0.5 in.	Contact Pattern sets CI, but is modified by series of questions	If Simp CI=40
Quoin Gap	$(W/H + 1'')/12$	Contact Pattern sets CI, but is modified by series of questions	If Simp CI=40

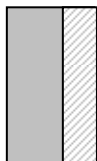
Bearing block gap is simplified by visually observing and recording a contact pattern on the bearing surfaces of the miter and quoin bearing blocks. The observation is based on the exposed height of bearing blocks from the top girder down to the DSWL. A series of additional questions will identify and quantify if gaps are present and also identify potential load distribution problems by gate behavior during loading and by the leaks that are present through the bearing surfaces after full head is applied.

Contact Patterns for bearing blocks:



Contact on 1/2 or more of block width for full exposed height (near center of block?)

CI = 85



Contact on 1/3 or less of block width on either edge for full height

CI = 70

Identify if contact is on upstream or downstream edge for record.



Contact on 1/8 or less of block width on either edge for full height

CI = 55

Identify if contact is on upstream or downstream edge for record.

A simplified CI is pre-defined by the selection of the contact pattern but then is modified as required when the following questions are answered. The deduct values would be applied to the respective bearing block set, Left Quoin (LQ), Miter, or Right Quoin (RQ), and will vary as noted within brackets following each question, for example, [Deduct 10 from CI if.....].

Q. Are there any severely worn, damaged, or missing bearing block sections?

Select bearing block	Estimate the distance below the top girder to the severely worn / damaged / missing section
LQ, Miter, RQ	(insert estimated foot value)

[Deduct 10 from respective bearing block per occurrence]

Gates at mitered position and stabilized with 1 ft of head pressure

Q. Estimate the size of gap at the top of the quoin block: 0, 1/16, 1/8, 1/4, 3/8, 1/2, or >

[Deduct 5 from respective quoin CI if gap = 1/8 or more]

[Deduct 10 from respective quoin CI if gap = 3/8 or more]



Q. Describe the profile of the miter blocks as they come together with 1 ft of head. The gap described in this profile is a gradual change, not localized wear or damage that might be seen at the pool levels.

Select the best description of the type of gap between the miter blocks	Estimate the Maximum width of the gap, select the nearest value	Estimate the distance below the top girder to the Max. gap location
1. A-type – closed at top and open wider at DSWL	0, 1/8, 1/4, 3/8, 1/2, 3/4, 1" or >	(insert estimated foot value)
2. V-type – open wider at top and closed at DSWL	0, 1/8, 1/4, 3/8, 1/2, 3/4, 1" or >	(insert estimated foot value)
3. O-type – closed at top and DSWL but open wider in middle	0, 1/8, 1/4, 3/8, 1/2, 3/4, 1" or >	(insert estimated foot value)

[Deduct 10 if gap type = (#1 and width of gap = 1/8 in. or >]

[Deduct 20 if gap type = (#1 and width of gap = 1/4 in. or >]

[Deduct 30 if gap type = (#1 and width of gap = 1/2 in. or >]

[Deduct 10 if gap type = (#2 or #3 and width of gap = 1/2 in. or >]

[Deduct 20 if gap type = (#2 or #3 and width of gap = 1 in. or >]

[Deduct 5 if gap type = (#3 and width of gap = 1/4 in. or >]

Gate observations as water load changes or with full head pressure

Q. Does the gap between miter blocks change during filling or emptying of the lock chamber? ( Yes / No )

[Deduct 5 from miter bearing block CI if Yes]

Q. Does the gap at the top of the quoin block close to "0" under full head? Yes / No

[Deduct additional 10 from respective quoin CI if No]

Q. Are there any leaks 6 in. or longer in a zone 1' above and below each girder?

Select bearing block	Estimate the distance below the top girder to the top of the leak
LQ, Miter, RQ	(insert estimated ft. value)

[Deduct 10 from respective bearing block per girder zone occurrence]

The trigger concept means that IF the Simplified CI calculates to equal 40 or less, THEN the recommendation would be to use the existing methods to get greater accuracy of measurements.

(NOTE: Based on collection of experiences, this approach, though lengthy, is probably a better way to evaluate bearing block gap than the existing methods. Miter gap is particularly suspect as it is currently evaluated and calculated. Quoin gap observations are difficult because visibility is limited.)

### **Downstream Movement**

Horizontally Framed Gate	Current Xmax	Proposed Simplified Xmax	Trigger
Downstream Movement	4 in.	None recommended	na

Downstream movement has not been simplified; the existing procedure and evaluation for CI should be maintained.

### **Cracks**

Horizontally Framed Gate	Current Xmax	Proposed Simplified Xmax	Trigger
Cracks – girders	1 occurrence	Xmax is same but revised inspection focus on critical sections of girders	na
Cracks – skin plate	10 occurrences	Xmax is same but revised recording	na
Cracks – intercostals	10 occurrences	Xmax is same but revised recording	na

The finding of Cracks is simplified by focusing the inspection on the critical sections of girders. The most significant simplification is the change that eliminates using a boat to get access to lower reaches of the gate for a close-up inspection. All observations are made from the top of the gate or the adjacent lockwall deck with binoculars or other visual enhancement devices. A systematic approach to viewing all visible components of the gate frame is recommended. Record all cracks in the girders, particularly concentrating on end framing and downstream flanges. Look for and record cracks on vertical web stiffeners and diagonals, particularly concentrating on gusset plates/connections and flanges. Record an obvious skin plate or intercostals crack but minimize effort spent looking for the distress.

A simplified CI is calculated in the same manner as the existing procedure.

The concept of the trigger is not applicable. Recommending the existing method would mean reverting to using the boat for the inspection of the lower reaches of the gate and that should be made on a case-by-case basis. Horizontally framed gates, particularly extremely tall gates, are more difficult to view from the top of the wall. An inspector will need to make the determination on each gate installation as to the ability to appropriately inspect the lower reaches of the gate.

### **Leaks and Boils**

<u>Horizontally Framed Gate</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
Skin plate leaks	15 ft	None recommended	na
Quoin/Miter block leaks	Gate Height/10 ft	None recommended	na
Boils	3 each	None recommended	na

Leaks and Boils has not been simplified; the existing procedure and evaluation for CI should be maintained.

### **Dents**

<u>Horizontally framed gate</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
Dents – girders	1 occurrence	No change proposed	na
Dents – skin plate	10 occurrence	Eliminated	
Dents – intercostals	3 occurrence	Eliminated	

The finding of Dents is simplified by focusing the inspection on the critical sections of girders. The most significant simplification is the change that eliminates using a boat to get access to lower reaches of the gate for a close-up inspection. All observations are made from the top of the gate or the adjacent lockwall deck with binoculars or other visual enhancement devices. A systematic approach to viewing all visible components of the gate frame is recommended. Only dents in the girders will count toward the simplified CI. Dents in skin plate or intercostals framing are not recorded.

A simplified CI is calculated in the same manner as the existing procedure.

### **Noise Jump & Vibration**

<u>Horizontal framed gate</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
NJV	Defined schedule	No Change	na

Predefined CI values are determined by observation of occurrences of noise, jump, or vibrations or the combination of occurrences.

NJV has not been simplified; the existing procedure and evaluation for CI should be maintained.

### **Corrosion**

<u>Horizontally Framed Gate</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
Corrosion – girders	Level 3	Average pit depth > 1/8 in. and inspection focus on critical sections of girders	na
Corrosion – skin plate	Level 4	Average pit depth > 1/8 in. when recorded	na
Corrosion – intercostals	Level 4	Average pit depth > 1/8 in. when recorded	na

Corrosion is simplified in a number of ways. The changes range from changing the method of interpreting and recording the level of corrosion present to focusing the inspection only on the critical sections of girders. The most significant simplification, however, is the change that eliminates using a boat to get access to lower reaches of the gate for a close-up inspection. All observations are made from the top of the gate or the adjacent lockwall deck with binoculars or other visual enhancement devices. A systematic approach to viewing all visible components of the gate frame is recommended.

The change in the method of interpreting and recording the level of corrosion is a big difference in “look” but very little difference in background concept. The current inspection procedure documents the Levels 0 through 5 for corrosion and the levels are illustrated by photograph and word description. In the new procedure for miter gates Level II inspection and evaluation, a revised concept for corrosion is proposed

that parallels the existing levels but is stated differently. The following table outlines the change for miter gate girders.

Old Corrosion Level and Description	Current CI Evaluation	New Corrosion Observation	Proposed CI Evaluation
0 – New condition	100	None	85
1 – Minor surface scale or widely scattered small pits	74	1/16" or less	70
2 – Considerable surface scale and/or moderate pitting	54	1/8" pits	55
3 – Severe pitting in dense pattern, thickness reduction in local areas	40	> 1/8" pits	40
4 – Obvious uniform thickness reduction	29	> 1/8" pits	40
5 – Holes due to thickness reduction and general thickness reduction	22	> 1/8" pits	40

Record the approximate average pit depth on the girders, particularly concentrating on splash zones. Look for and record pit depths of 1/8 in. or greater on vertical web stiffener beams and diagonals, particularly concentrating on splash zones. Look for and record pit depths of 1/8 in. or greater on skin plate and intercostals.

A simplified CI is calculated in the same manner as the existing procedure.

The concept of the trigger is not applicable. Recommending the existing method would mean reverting to using the boat for the inspection of the lower reaches of the gate and that should be made on a case-by-case basis. Horizontally framed gates, particularly extremely tall gates, are more difficult to view from the top of the wall. An inspector will need to make the determination on each gate installation as to the ability to appropriately inspect the lower reaches of the gate.

## Appendix B: CI Simplification for Vertically Framed Miter Gate

*Lock & Dam Investigation Inc, Ames, IA, July 2001*  
*David T. McKay and Stuart D. Foltz, ERDC/CERL, 2002*

Proposed simplifications of observations, data readings and recordings for condition index inspection and evaluation of distress components:

### Anchorage System

<u>Vertically framed gate</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
Location #1	0.030 unless flexible	similar to existing procedure	na
Location #2	$(0.25 * W/H)$	new Yes/No questions, revised CI calc	1/8 in. or >
Location #3	$(0.18 * W/H)$	new procedure & $X_{max} = (0.025 * W/H)$	$(0.015 * W/H)$

Location #1 (at concrete embedment) – Only a minor change from the existing procedure is proposed. Dial gauge readings would be recorded when the miter gate is mitered with a full head of water load, at a new position called off-miter (gate just broken from mitered position), and in recess position. These readings will yield an observation of the full extension/compression of both anchor arms.

A simplified CI could be calculated using the existing Xmax criteria.

Location #2 (across linkages) – The proposed procedure is similar to the existing procedure. The linkage bar may be configured in several ways including turnbuckles, wedge plate assemblies, and connecting pins. The existing CI is determined by the total change in length of the anchor arm, across all linkage pieces. Various ways of observing and recording this total change have been used, but the simplest and most useful has been to record data at each individual linkage interface and sum the individual changes.

In the proposed simplified procedure, at each interface where movement could occur, the question of movement would be asked and quantified by a simple Yes/No query:

Is there evidence of movement? Y / N, and then how much?  $<1/16$ ,  $1/16$ ,  $1/8$ ,  $1/4$ ,  $>1/4$

The observation of each interface would cover the full range of gate operation, from mitered to recessed. An inspector may use a setup of dial gauges to help in this determination, but it would not be required.

A simplified CI could be calculated by summing the values returned for each interface query, then evaluating the total value versus the existing Xmax for Location 2, (0.25 inches \*W/H). The simplified CI would be set to a max of CI = 85 if all queries were No on the question of movement, and a max of CI = 70 if any of the queries were Yes on the question of movement.

The trigger concept means that IF the #2 reading is recorded as  $1/8$  or greater, THEN the recommendation would be to use the existing methods to get greater accuracy of measurements.

Location #3 (at the gudgeon pin) – The proposed change to the inspection procedure is significantly different from the existing procedure. However, it provides the ability to observe movement of the gate assembly at points in the gate operation cycle when the most likely reason for this movement is due to wear (and hence a gap) within the gudgeon pin/bushing connection. The proposed change would observe the movement of the gate frame relative to the wall at two unique gate positions during the gate operation cycle. The first gate position starts with the gate mitered and under full head pressure from the normal pool levels. Several dial gauge readings are taken from full head and as the head pressure is removed and the gate broken off miter by “bumping” the operating equipment. This change in relative position (to the wall and the parallel anchorage arm) is nearly instantaneous but can be quantified by observing dial gauge readings and indicator needle behavior. The second gate position is when the gate is initially being pushed away from the recess position against the wall. Again, this change in relative position (to the wall and the perpendicular anchorage arm) is nearly instantaneous but can be quantified by observing dial gauge readings and indicator needle behavior.

At Location #3 this new simplified concept would use simple apparatus and dial gauge devices set up on the grating above both perpendicular and parallel anchor

arms. A preliminary setup of devices when the miter gate is in the mitered position is shown in the following photos:

#### Parallel Anchor Arm



The dial gauge is attached to a cantilevered angle that is secured to the grating installed over the anchor pit. The dial gauge spindle bears against the side of the vertical leg on the angle that is setting on the gate grating. The angle and dial gauge are aligned on the axis of the parallel anchor arm. In many instances, the grating on the gate frame fills the gap and the dial gauge may be placed directly on the grating similar to the second photo.

#### Perpendicular Anchor Arm



The dial gauge is placed directly on the grating installed over the anchor pit, and the spindle bears against the side of the vertical leg on the angle that is setting on the gate grating. The angle and the dial gauge are aligned on the axis of the perpendicular anchor arm.

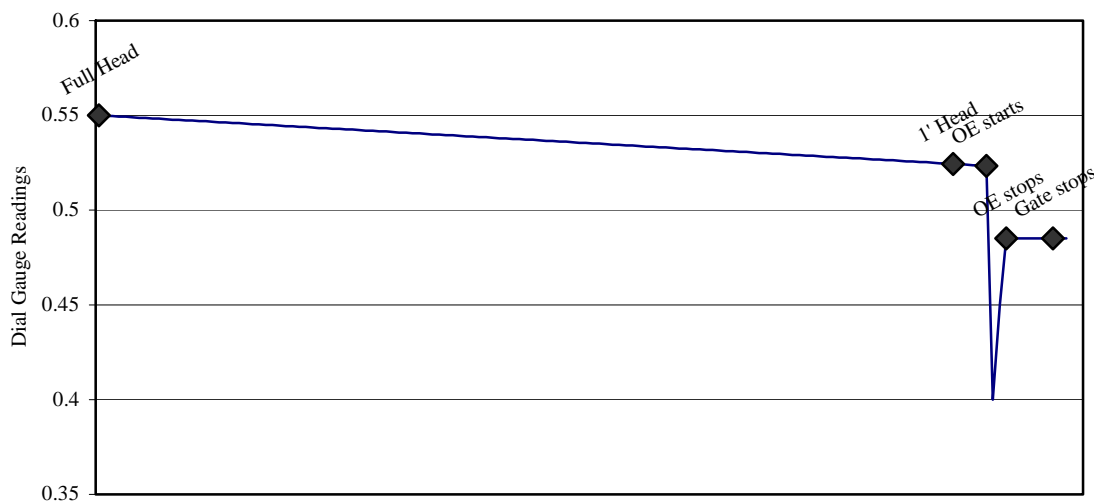
In the proposed simplified procedure, the principal observation readings would be taken when the miter gate is pulled off of the mitered condition by the operating equipment. An initial dial gauge reading of the dial gauges set up over both anchor arms would be taken with the gate mitered and under full load. The dial gauges would then be observed during the operation time that the miter gate is unloaded (i.e., the lock chamber pool raised or lowered to equalize water levels). A dial gauge reading would be recorded at approximately 1-ft head to track the change due to head pressure. As the chamber pool is leveled with the respective pool, the gate may drift open slightly due to overfill (or emptying) of the chamber. Then, the OE would be operated briefly (commonly called “bumped”) to break the gate seal off the quoin wall and miter point. When the gate breaks off seal, the OE pulls the quoin end of the gate upstream and off the quoin block, using up any gap that may exist in the pin/bushing interface. This movement is captured by the dial gauge over the parallel arm with a rapid needle spin and spike point. The maximum spike reading



would be estimated and recorded. The OE will finally begin to pull the miter end of the gate around and the parallel arm dial gauge will back off its maximum reading. When the gate movement has stopped from this initial bump by the OE, the second dial gauge readings of both parallel and perpendicular arms are taken and recorded. The maximum differential of the two fixed readings and the estimated reading of the spike point will be used to calculate a CI for the off-miter movement.

The chart below illustrates the time line and spike pattern of the dial gauge readings an inspector might observe. The time elapsed from Full Head to 1-ft Head and finally to OE starts may be minutes, and only a very small change in the dial gauge readings might be observed. The time elapsed from OE starts to OE stops is a few seconds. The spike occurs in a fraction of a second but is easily observed and estimated after just a few trial runs.

Example of tracking of readings at parallel anchorage arm of miter gate



Load cycle and actions by OE over time

The second observation reading would be made as the miter gate is pushed away from the recessed position against the wall. A second apparatus setup of a vertical angle and dial gauge similar to the perpendicular anchor arm seen in the earlier photograph would be used to capture the movement as the OE is used to bump the gate away from the wall. This setup is only over the perpendicular arm. The first dial gauge reading is recorded as the miter gate is held in the recessed position. As the gate is pushed out of the recessed position, the OE initially pushes the quoin end of the gate out towards the lock chamber before the miter point starts to move, using up any gap that may exist in the pin/bushing interface. This movement is captured by the dial gauge over the perpendicular arm with a rapid needle spin and

spike point. The maximum spike reading would be estimated and recorded. The OE will finally begin to push the miter end of the gate around and the perpendicular arm dial gauge will back off its maximum reading. When the gate movement has stopped from this initial bump by the OE, the second dial gauge reading of the perpendicular arm is taken and recorded. The maximum differential of the two fixed readings and the estimated reading of the spike point will be used to calculate a CI for the off-recess movement.

A simplified CI for Location #3 could be calculated for both gate positions using the dial gauge readings collected and evaluating them versus a new modified Xmax. The existing value of Xmax at Location #3 is determined by the rule (0.180 inches \* W/H ratio), which can yield an actual Xmax of 0.090 inches for a 1/2 ratio or 0.360 for a 2/1 ratio. A review of data collected on approximately 25 inspections conducted by LDI in recent years suggests that using a simple modification factor applied to the existing Xmax rule will correlate reasonably well to existing CI values. Adding a modification factor to the rule changes the range of the calculated Xmax but not the concept. A more thorough discussion of the data and application of the modification factor will be included in the report. A final value for this modification factor will be determined in concert with field-testing and discussion with COE personnel. A preliminary new modified Xmax value (derived by application of the factor to the rule) is set as (0.025\*W/H).

The calculation of the aggregate CI for Anchorage System is not changed; it will still be the minimum of the component CIs in the system.

The trigger concept means that IF the #3 reading is greater than  $0.015 * W/H$ , THEN the recommendation would be to use the existing methods to get greater accuracy of measurements.

### **Elevation Change**

<u>Vertically framed gate</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
Elev. Change – miter	0.08 (W/H)	Eliminate Measurements and set CI = 85 of miter blocks or other factors	Diff. Elev.
Elev. change – quoin	0.05 ft.	Eliminate Measurements and set CI = 85	na

Elevation change is simplified by eliminating miter point and quoin elevation measurements unless other factors noted in the trigger are present.

The simplified CI is set to 85 unless normal elevation measurements are taken.

The trigger concept means IF differential height on miter bearing blocks is 1 1/2 in. or greater, OR diagonals flap (from NJV), OR if anchorage #3 is triggered, THEN normal elevation data should be taken.

### **Miter Offset**

<u>Vertically framed gate</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
Miter Offset	0.5*(Block width)	0.5*BW but new procedure	3/8 BW

Miter Offset is simplified by visually observing (but not measuring) the miter block offset condition and then recording the offset of the miter blocks on the top girder as 1/8, 1/4, 3/8, or 1/2 of block width, and also recording which gate block is downstream with respect to the other gate block. At the same time, record the differential heights of the top of the miter blocks as a simplified reading on Elevations.

A simplified CI is calculated by evaluating the value returned by the offset selection versus the existing Xmax rules for miter offset.

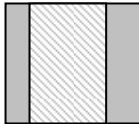
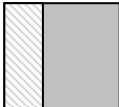
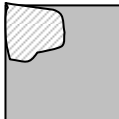

The trigger concept means that IF the Miter Offset selection is 3/8, THEN the recommendation would be to use the existing methods to get greater accuracy of measurements.

### **Bearing Gaps**

<u>Vertically framed gate</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
Miter Gap	0.5 in.	Contact pattern defines CI, If No Contact then CI=40	No Contact
Quoin Gap	0.5 in.	Contact pattern defines CI, If No Contact then CI=40	No Contact

Bearing block gap is simplified by visually observing and recording a contact pattern on the bearing surfaces of the miter and quoin bearing blocks.

Contact Patterns for bearing blocks:

	Contact on 1/2 or more of block width for full height of block:
	CI = 85
	Contact on 1/3 or less of block width on either edge for full height:
	CI = 70
	Contact on any 1/4 quadrant of block and not full height:
	CI = 55
	No Contact:
	CI = 40

A simplified CI is predefined by the selection of the contact pattern.

The trigger concept means that IF No Contact is recorded for a contact pattern on the miter blocks, THEN the recommendation would be to use the existing methods to obtain greater accuracy of measurements.

### **Downstream Movement**

Vertically framed gate	Current Xmax	Proposed Simplified Xmax	Trigger
Downstream Movement	4 in.	Eliminate Measurements and set CI = 85	Miter gap Miter offset >1/8

Downstream movement is simplified by eliminating downstream movement measurements unless other factors noted in the trigger are present.

The simplified CI is set to 85 unless normal downstream measurements are taken.

The trigger concept means IF miter gap is present AND offset is greater than 1/8 BW, THEN the recommendation would be to use the current method to record downstream measurements.

## **Cracks**

<u>Vertically framed gate</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
Cracks – girders	1 occurrence	Xmax is same but revised inspection focus on top girder	na
Cracks – skin plate	10 occurrences	Xmax is same but revised recording	na
Cracks – intercostals	10 occurrences	Xmax is same but revised recording	na

Cracks is simplified by focusing the inspection on the top girder. The most significant simplification is the change that eliminates using a boat to get access to lower reaches of the gate for a close-up inspection. All observations are made from the top of the gate or the adjacent lockwall deck with binoculars or other visual enhancement devices. A systematic approach to viewing all visible components of the gate frame is recommended. Record all cracks in the top girder and look for and record cracks on vertical beams and diagonals, particularly concentrating on gusset plates/connections and downstream flanges. Record an obvious skin plate or intercostals crack but minimize effort spent looking for the distress.

The concept of the trigger is not applicable. Recommending the existing method would mean reverting to using the boat for the inspection of the lower reaches of the gate and that should be made on a case-by-case basis. An inspector will need to make the determination on each gate installation as to the ability to appropriately inspect the lower reaches of the gate.

## **Leaks and Boils**

<u>Vertically Framed Gate</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
Skin plate leaks	15 ft	None recommended	na
Quoin/Miter seal leaks	Gate Height/5 ft	None recommended	na
Boils	3 each	None recommended	na

Leaks and Boils has not been simplified; the existing procedure and evaluation for CI should be maintained.

## **Dents**

<u>Vertically framed gate</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
Dents – girders	1 occurrence	Xmax = 1, but only on the top girder	na
Dents – skin plate	10 occurrence	Eliminated	
Dents – intercostals	3 occurrence	Eliminated	

Dents is simplified by focusing on the top girder. The most significant simplification is the change that eliminates using a boat to get access to lower reaches of the gate for a close-up inspection. All observations are made from the top of the gate or the adjacent lockwall deck with binoculars or other visual enhancement devices. A systematic approach to viewing all visible components of the gate frame is recommended. Only dents on the top girder will count toward the simplified CI. Dents on vertical beams may be recorded for mapping but will not be included in the CI calc. Dents in skin plate or intercostals framing are not recorded.

A simplified CI is calculated in the same manner as the existing procedure.

The concept of the trigger is not applicable. Recommending the existing method would mean reverting to using the boat for the inspection of the lower reaches of the gate and that should be made on a case-by-case basis. An inspector will need to make the determination on each gate installation as to the ability to appropriately inspect the lower reaches of the gate.

## **Noise Jump & Vibration**

<u>Horizontal Framed Gate</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
NJV	Defined schedule	No Change	na

Predefined CI values are determined by observation of occurrences of noise, jump, or vibrations or the combination of occurrences.

NJV has not been simplified; the existing procedure and evaluation for CI should be maintained.

## Corrosion

Vertically Framed Gate	Current Xmax	Proposed Simplified Xmax	Trigger
Corrosion – girders	Level 3	Average pit depth > 1/8 in. and inspections focus on critical sections of the top girder	na
Corrosion – skin plate	Level 4	Average pit depth > 1/8 in. when recorded	na
Corrosion – intercostals	Level 4	Average pit depth > 1/8 in. when recorded	na

Corrosion is simplified in a number of ways. The changes range from changing the method of interpreting and recording the level of corrosion present to focusing the inspection on the top girder. However, the most significant simplification is the change that eliminates using a boat to get access to lower reaches of the gate for a close-up inspection. All observations are made from the top of the gate or the adjacent lockwall deck with binoculars or other visual enhancement devices. A systematic approach to viewing all visible components of the gate frame is recommended.

The change in the method of interpreting and recording the level of corrosion is a big difference in “look” but very little difference in background concept. The current inspection procedure documents the Levels 0 through 5 for corrosion and the levels are illustrated by photograph and word description. In the new procedure for miter gates Level II inspection and evaluation, a revised concept for corrosion is proposed that parallels the existing levels but is stated differently. The following table outlines the change for miter gate girders.

Old Corrosion Level and Description	Current CI Evaluation	New Corrosion Observation	Proposed CI Evaluation
0 – New condition	100	None	85
1 – Minor surface scale or widely scattered small pits	74	1/16 in. or less	70
2 – Considerable surface scale and/or moderate pitting	54	1/8 in. pits	55
3 – Severe pitting in dense pattern, thickness reduction in local areas	40	> 1/8 in. pits	40
4 – Obvious uniform thickness reduction	29	> 1/8 in. pits	40
5 – Holes due to thickness reduction and general thickness reduction	22	> 1/8 in. pits	40

Record the approximate average pit depth on the girders, particularly concentrating on splash zones. Look for and record pit depths of 1/8 in. or greater on vertical web stiffener beams and diagonals, particularly concentrating on splash zones. Look for and record pit depths of 1/8 in. or greater on skin plate and intercostals.

A simplified CI is calculated in the same manner as the existing procedure.

The concept of the trigger is not applicable. Recommending the existing method would mean reverting to using the boat for the inspection of the lower reaches of the gate and that should be made on a case-by-case basis. An inspector will need to make the determination on each gate installation as to the ability to appropriately inspect the lower reaches of the gate.



## Appendix C: CI Simplification for Tainter Dam and Lock Gates

*Lock & Dam Investigation Inc, Ames, IA, July 2001*

*David T. McKay and Stuart D. Foltz, ERDC/CERL, 2002*

Proposed simplifications of observations, data readings, and recordings for CI inspection and evaluation of distress components:

The current procedures for the inspection and evaluation of tainter dam and lock gates for determining a CI is already adapted into two sub-procedures. One is called a Normal Operating inspection and the second is called a Bulkheaded inspection. As the name implies, the Normal Operating inspection is structured to allow observation and data collection to proceed under nominally normal or everyday operating conditions; whereas the Bulkheaded inspection requires the capability to load / unload the anchorages and also allows the inspection to lift the entire gate body clear of the water for full observation of all structure components. A full comparison of the two inspection processes can be found in the Technical Report REMR-OM-17, September 1995.

In the previous study outlining potential time-saving for tainter gates (LDI Task 1, December 2000), it was shown that the work activity of bulkheading the tainter dam or lock gate was the most time consuming component of the inspection. The second major time activity was associated with the inspection of the gate body using a man-basket to access the gate so as to traverse across the backside of the gate and view individual components of the gate. At most projects, the equipment and manpower required to facilitate bulkheading of the gate are also the same resources that are required to support a man-basket inspection. Thus, if the objective is a Bulkheaded inspection, it is expected that most inspection teams would also take advantage of the capability to do a more thorough on-the-gate inspection and use a man-basket.

In consideration of simplifications to the tainter gate inspection procedure, only changes to the Normal Operating procedure were developed and recommended for

implementation. For all practical purposes, the Normal Operating procedure becomes the Level III Simplified CI Procedure for tainter dam and lock gates and the current procedures for a Bulkheaded inspection becomes the detailed Level III procedure that is triggered by data observations in the simplified inspection.

## Summary of Proposed Simplifications to Normal Operating Procedure

The proposed simplifications generally fall into three categories. Each of the categories affect multiple distresses and the details can be found in the sections in each distress. The general nature of the three simplifications is outlined below:

1. Delete the use of a man-basket for close-up inspection work. However, some gates are set up to easily and safely climb onto the framework and work around the structure. This simplification does not preclude close-up inspection of the gate, just the requirement to do it with a man-basket.
2. Eliminate several measurements that experience has shown to be ineffective. For example, misalignment (requires a third person for this one activity or someone needs to climb pier ladders several additional times), and trammel points for long-term measurements.
3. Reduce the observation detail for a number of distresses. For example, revise inspection technique for corrosion from counting pits to assigning a corrosion level of pitting.

Specific simplifications are outlined in each of the following sections organized by the distresses as found in Technical Report REMR-OM-17.

### Noise Jump & Vibration

Normal Operating	Current Xmax	Proposed Simplified Xmax	Trigger
NJV	Defined schedule	No Change	na

Predefined CI values are determined by observation and recording of occurrences of noise, jump, or vibrations or the combination of occurrences.

NJV has not been simplified; the existing procedure and evaluation for CI should be maintained.

## Vibration with Flow

<u>Normal Operating</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
Vibration w/ flow	Defined schedule	No Change	na

Predefined CI values are determined by observation and recording of the presence of vibrations with the gate raised off the sill to a 2-ft gate opening.

Vibration with flow has not been simplified; the existing procedure and evaluation for CI should be maintained.

## Misalignment

<u>Normal Operating</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
	(.25 in)*(W/H)	Eliminate measurements and set CI = 85, Use Yes/No questions to further modify calculated CI	If "No" on recent operation

Misalignment is simplified by using visual observations and project operations records to calculate a simplified CI. If a gate has been operated within the past 12 months to a gate opening that is at least 75 percent of the maximum gate travel, then the Simplified CI is set to equal 85. Further modifications of the simplified CI are made based on responses to Yes / No questions on the inspection form. They are:

- Set CI = 70 if gate has been operated but the lift range was not up to the 75 percent minimum
- Set CI = 55 if gate experienced binding at any point in the gate lift
- Set CI = 40 if gate lift and travel needed to be stopped due to the binding
- Reduce simplified or modified CI by one step (15 points, but not lower than CI = 40) if any of the gouging, binding, or deterioration questions are answered Yes.

The trigger concept means that IF the gate has not been operated in the past twelve months, THEN the recommendation would be to use the existing methods to gather information for calculating a condition index.

## Anchorage Assembly Deterioration

Normal Operating	Current Xmax	Proposed Simplified Xmax	Trigger
Short term - Rigid	0.005 in.	No Change	Prel. CI= 5 or if Growing Cracks = Y
Short term - Flex.	0.0001(L) in.	No Change	Prel. CI = 55 or if Growing Cracks = Y
Long term - Rigid	0.125 in.	Delete this measurement	none
Long term - Flex.	0.0025(L) in.	Delete this measurement	none

Anchorage assembly deterioration is simplified by deleting the long-term measurements made with a trammel measuring device. Experience has indicated that the likelihood of securing reliable data with this technique is low. This is expected to have little impact, but long-term field data have never been collected or tested. (Note: The short-term measurements using a dial gauge to observe movement while operating the tainter gate from the sill to a 2-ft gate opening is still part of the procedure.)

An additional question regarding cracks in concrete in the anchorage zone has been added. The anchorage zone is the section of the concrete pier or monolith that is surrounding the embedded anchor bolts or tendons. Cracks in this section of the concrete pier, particularly growing cracks, may be indicative of anchorage movement; and at the least they provide an entrance point for moisture into the section that may encourage corrosion of the embedded anchorage. A “Yes” answer to the question, “Are cracks in pier extending to anchorage zone?” will be interpreted in the same manner as the question “Is concrete cracked or spalled at base?” The CI for the anchorage will be reduced by a factor of 0.85. This reduction for cracked concrete will only be applied once. (Note: The rule “If any of the anchor or casting bolts and nuts are corroded, loose, or missing, the CI decreases by a 0.7 factor” is also still true. When more than one reduction factor is applicable, the CI is reduced by only the most severe reduction factor.)

The trigger concept means that IF the preliminary CI calculated for the anchorage assembly equals 55 or less prior to the application of reduction factors, THEN the recommendation would be to use the Bulkheaded procedure to get a more accurate measurement of anchorage movement. A second trigger is recommended for concrete cracks. IF a “Yes” is recorded to the question on growing cracks in the anchor-

age zone, THEN the recommendation would be to use the Bulkheaded procedure to get a more accurate measurement of anchorage movement.

### Trunnion Assembly Wear

Normal Operating	Current Xmax	Proposed Simplified Xmax	Trigger
Lateral Movement	0.375 in.	No Change	none
Short term - Total	0.125 in.	Xmax is same but new procedure and defined CIs may apply or cannot calc CI	If Simp CI = 40
Long term - Total	0.125 in.	Delete this measurement	none

Trunnion assembly wear is simplified in two ways. First, the observations of short-term movement are simplified by only requiring the physical measurement of pin/bushing gap when the end of the pin and edge of the bushing is exposed and accessible, and feeler gauges may be used. The requirement on closed end assemblies to set up and record vertical and horizontal movement with dial gauges is deleted. Experience has indicated that the likelihood of securing reliable data with this technique is low unless it is done regularly and the results from several inspections can be analyzed for trends. This is expected to have little impact. Several new questions for visually observing and recording evidence of trunnion bushing wear and lubrication are added as well as refinements to the data collection for feeler gauges.

The second simplification is made by deleting the long term measurements made with a trammel measuring device. Experience has indicated that the likelihood of securing reliable data with this technique is low. This is expected to have little impact, but long-term field data has never been collected or tested.

The CI for trunnion assembly wear is the minimum of the lateral movement CI and the total movement CI on either trunnion assembly. The lateral movement CI will be calculated according to the same rules and procedure as the current method. The revised method for calculating the total movement CI is as follows.

For open end trunnion assembly systems (where a feeler gauge may be used):

1. The Simplified CI will be calculated using the collected feeler gauge data. This initial CI may be modified by the existing lubrication problem reduction factor

(0.85) or a new reduction factor (of 0.7) that accounts for wear problems caused by a rotating or seized bushing or a reduced bushing shell thickness. The reduction factors will be applied if the respective questions are answered “Yes”. When more than one reduction factor is applicable, the CI is reduced by only the most severe reduction factor.

2. If feeler gauge measurements are not taken, the Simplified CI is set to equal 55. This initial CI may be modified by the existing lubrication problem reduction factor (0.85) or the new reduction factor for a rotating, seized, or reduced shell bushing (0.7). When more than one reduction factor is applicable, the CI is reduced by only the most severe reduction factor.

For closed end trunnion assembly systems (no direct measurement can be made):

1. The Simplified CI will be defined to equal 85. This initial CI may be modified by the existing lubrication problem reduction factor (0.85).
2. If any one of the trunnion wear questions are answered with a “Yes,” then a simplified CI should not be calculated.

The trigger concept means that IF the calculated CI for the trunnion wear assembly equals 40 or less, OR IF a CI cannot be calculated, THEN the recommendation would be to use the Bulkheaded procedure to get a more accurate measurement of trunnion wear.

## Cracks

Normal Operating	Current Xmax	Proposed Simplified Xmax	Trigger
Cracks – strut arms,	1 occurrence	No change, the components remain	Requires trunnion yokes, hub, critical sections and CI = 30 for Close-up or trunnion girder component and for gate Inspection
Cracks – main girders	1 occurrence	Xmax is same but revised recording	Requires Close-up Inspection
Cracks – ribs & bracing	1 occurrence	Xmax is same but revised recording	na
Cracks – skin plates	3 occurrences	Xmax is same but revised recording	na

Cracks is simplified by focusing the inspection on the critical sections of the trunnion girder, strut arms, and main girders. The most significant simplification is the change that eliminates using a man-basket to access the gate for a close-up inspection. All observations are made from the adjacent trunnion anchorage deck with binoculars or other visual enhancement devices. A systematic approach to viewing all visible components of the gate frame is recommended. Record all cracks in the trunnion girder, trunnion yoke, trunnion hub, strut arms and main girders, particularly concentrating on end framing and tension flanges. Look for and record cracks on vertical ribs and bracing, particularly concentrating on gusset plates/connections and flanges. Record an obvious skin plate or intercostals crack, but minimize effort spent looking for these distresses.

A simplified CI is calculated in the same way as the existing procedure.

The trigger concept means the IF a crack is suspected and recorded in any of the major components, including trunnion girder, strut arms or main girders, THEN a close-up inspection is required whether it be by climbing, man-basket, or other means.

## Dents

Normal Operating	Current Xmax	Proposed Simplified Xmax	Trigger
Dents – main girders and strut arms	1 occurrence	Xmax is same but revised recording	none
Dents – ribs & bracing	3 occurrences	Xmax is same but revised recording	na
Dents – skin plates	10 occurrences	Xmax is same but revised recording	na

Dents is simplified by focusing the inspection on the critical sections of the strut arms and main girders. The most significant simplification is the change that eliminates using a man-basket to get access to the gate for a close-up inspection. All observations are made from the adjacent trunnion anchorage deck with binoculars or other visual enhancement devices. A systematic approach to viewing all visible components of the gate frame is recommended. Record all dents in the strut arms and main girders, particularly concentrating on end framing and compression flanges. Only dents in the strut arms and girders are included in the simplified CI.

Dents in ribs and bracing may be recorded for documentation, but dents in skin plate or intercostals framing are not recorded.

A simplified CI is calculated in the same way as the existing procedure.

## Corrosion

Normal Operating	Current Xmax	Proposed Simplified Xmax	Trigger
Corrosion – girders and strut arms	10% Section loss	Average pit depth > 1/8 in. and inspection focus on critical sections of girders	CI = 40
Corrosion – skin plate	20% Loss	Average pit depth > 1/8 in. when recorded	
Corrosion – ribs & bracing	20% Loss	Average pit depth > 1/8 in. when recorded	

Corrosion is simplified in a number of ways. The changes range from changing the method of interpreting and recording the level of corrosion present to focusing the inspection on the main girders and strut arms. However, the most significant simplification is the elimination of a man-basket to get access to the gate for a close-up inspection. All observations are made from the adjacent trunnion anchorage deck with binoculars or other visual enhancement devices. A systematic approach to viewing all visible components of the gate frame is recommended.

The change in the method of interpreting and recording the level of detail of corrosion is a reduction in the detail approach to finding a representative square foot and then counting and sizing the pits. The proposed method involves the same survey of the structure frame looking for a representative area, but then the average pit depth is estimated and recorded on the selected major components.

A simplified CI is defined based on the selection of corrosion pit depth in accordance with the following table:

New Corrosion Observation	Proposed CI Evaluation
None	85
1/16 in. or less	70
1/8 in. pits	55
> 1/8 in. pits	40



The trigger concept means that IF corrosion is observed and recorded as “> 1/8 in. pits” in any of the major components, including trunnion girder, strut arms, or main girders, THEN a close-up inspection is required whether it be by climbing, man-basket, or other means.

### Cable/Chain Plate Wear

<u>Normal Operating</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
Cable/chain plate wear	25–50% of plate section	No change	na

Cable/chain plate wear observation will only be considered under Normal Operating conditions when the wear is visible. The original combined CI already provides for this distress CI to be ignored when it is not able to be quantified.

The simplified CI will be calculated using existing procedures.

### Leaks

<u>Normal Operating</u>	<u>Current Xmax</u>	<u>Proposed Simplified Xmax</u>	<u>Trigger</u>
Perimeter –			
power plant	2% of wet perim.	No change	na
non-power plant	10% of wet perim.	No change	na
non-power plant and submersible	30% of wet perim.	No change	na

Leaks and Boils has not been simplified; the existing procedure and evaluation for the CI should be maintained.

**Seal Condition** is not considered a CI distress but has been included on the inspection form as a convenient place to document a condition that is readily observed in conjunction with other gate frame observations. It is useful as a reference condition when analyzing other related distresses.

## Appendix D: Multi-Level (I) Evaluation of Miter and Tainter Gates

*Lock & Dam Investigations, Inc., Ames, IA*

*David T. McKay and Stuart D. Foltz (USACE/ERDC)*

The concept of the Level I condition assessment and evaluation is to determine the need for higher levels of inspection and, if needed, the appropriate level of inspection effort that is required to reach an acceptable conclusion as to the likely condition of a structure.

### State of Condition of a Structure

The state of condition on the majority of components at a civil works project changes very slowly. It is generally accepted that, shortly after placing a component into service, the condition of the component begins deteriorating, but there is not always general agreement on the rate of deterioration. However, the rate of deterioration for miter and tainter gates components is typically slow and occurs over many years, sometimes several decades. The only thing that will change that slow rate of deterioration is an event that impacts directly on a particular component. For example, a fender system on a gate may last 10 years or until the first barge collision. The barge collision is an event that impacts on the rate of deterioration of the fenders and the expected service life. Examples of events that would impact on service life of miter or tainter gate components are:

- Accidents
- Ice jams or debris fields that make operations difficult and damage components
- Flood events
- Interruption of or lack of maintenance on a component

There are numerous other types of factors that can enter into determining the service life of a structure component or a collection of components. Some of those are:

- Increase/decrease in operation cycles from the norm

- Revised design criteria
- Revised function of the structure, perhaps increasing head load
- Repairs or additions of parts to a structure

In today's Corps of Engineers, detailed records are kept of such events. The project and district engineers have records for the engineering factors that could impact the service life. The availability of information via databases or electronic correspondence makes it increasingly possible to monitor and evaluate structure condition without a site visit every time the structure is under review. Thus, at a very specific point in time, a likely state of condition for a component, could reasonably be determined from two sets of data:

1. A known state of condition at a particular previous point in time
2. The occurrence of events that may have changed that state in the intervening time period.

The first set of data could be the easiest to establish. For example, the structure was new 5 years earlier, or the structure may have been completely rehabilitated 5 years earlier. In the absence of information to the contrary, it could be assumed the structure started out in Excellent condition or was rebuilt to an Excellent condition. Another way to establish a known state of condition would be by a previous inspection that is well documented, such as an engineering report or the results of a Level II or Level III CI inspection. The state of condition might be quantified subjectively as Good or Fair; or it may be quantified numerically by the REMR CI Scale. This data set is used as the reference point and establishes the start date for the review period.

The second set of data will be gleaned from records available at the project and district level. The precise nature of the data will vary by project and geographic area. The reviewer will also need to have personal knowledge or receive other input to be able to make an assessment of the impact of the passage of time at a specific project.

## **The Decision Process**

This process will be similar to a decision tree, where the responses to certain questions will be the determinant for continuation or termination of the process. The details of the decision tree questions and the potential result strategies will be de-

terminated in consultation with Corps of Engineers personnel but a preliminary outline is provided.

### ***The collection of information***

- The known state of condition of the structure or component at a specific point in time; this could be more than one record, spanning a number of years. The last record and date is the most pertinent but the others could provide insight into deterioration rate.
- The history of the structure including inspections, repairs, rehabs, and the associated dates; particularly since the last record
- Project information pertinent to events within the review period (from project or district logs)
- Review of project operations logs for operational problems and interviews of personnel to determine current status of problem
- Personal knowledge of the project or structure
- A history of similar structures subjected to similar conditions

### ***Questions that need to be answered***

- What do we need to know?
- What will the results be used for?
- Are all components of the structure in the query or only unique sub-components?
- Is the query urgent, needed quickly but not critical, or a routine inspection requirement? (More appropriate descriptions will emerge later, and it is possible “urgent” queries may not enter this process.)

### ***Criterion that will enter into decision-making process***

- Presence of operational problems or concerns by operations personnel
- Type and severity of event(s) that directly impacted structure since last review
- State of condition of the structure at the last determination
- Length of time since last determination of state of condition (current review period)
- Method used to determine the last state of condition and its scope
- Age of the structure or its probable remaining service life
- Performance of similar structures under similar conditions

***Possible outcomes of the Level I condition review***

- Re-affirm previous state of condition without site visit (default)
- Recommend a Level II inspection
- Recommend a Level III inspection
- Recommend a Level IV inspection

**Minimum Requirements for Each Inspection Level**

The simplest way to outline which inspection level would be recommended is by starting at the highest level, Level IV.

Level IV is required IF:

- A life-safety issue is the reason for the query.
- The structure or component undergoes a severe loading that could have caused serious structural problems or threatened the stability of the structure.
- A recent Level III CI inspection had an Overall Structure CI equal 39 or lower. This re-inspection should occur within a maximum of 6 months.
- A recent Level III CI inspection had an Overall Structure CI in the Marginal range, 40 to 54 but an important individual component CI was less than 40. Engineering judgment will be applied in the review of the component distress to determine if a Level IV review is needed.
- The nature of the information required will not be produced by a lower level inspection, for example, a stress analysis of the lower section girder framing.

Level III is recommended IF:

- A recent Level II CI inspection had a majority of the individual component CI's rate a Marginal Condition. The interval of time between the Level II inspection and the Level III inspection should not exceed 2 years.
- A current Level II CI inspection has an individual component CI rate a Poor Condition. This re-inspection should occur as quickly as possible to verify the condition; a maximum of 6 months is recommended.
- A structure has reached the one-third point of its projected service life and has not recorded a Level III inspection to establish a base-line of condition.

- A period of at least 2 to 5 years has passed since the last condition Level III assessment AND that condition rating was below 40.

Level II is recommended IF:

- There is evidence of operational problems resulting from an event and project personnel express concern.
- A structure has been rehabilitated and a period of 5 years has passed since the completion of the work but the structure has not yet recorded a Level II or Level III inspection to establish a new base-line of condition since the rehabilitation work.
- A period of 5 to 10 years has passed since the last condition assessment has been recorded for a structure and intervening condition assessments have all been Level I.
- A period of 2 (at least) to 5 years has passed since the last condition assessment AND that condition rating was below 70.

Level I is allowed to be the default condition rating procedure:

- For all structures that have been free of any serious event occurrence in the previous 4-year period and do not have any record of operational problems or project personnel concerns, UNLESS one of the conditions for Level II or Level III recommendations are met.
- For all structures that have a Level II or Level III inspection record on file dated within the last 5 years AND all condition ratings of the individual distresses rate in the condition categories of Good or higher, this is a CI = 70.
- For all new structures that have been in service for less than one-third of its projected service life and have not been previously rated for condition.

**Multi-Level (I) Evaluation Form for Miter and/or Tainter Gates**

Project Name: \_\_\_\_\_

The project was placed in service on: (date)\_\_\_\_\_

The project has been rehabilitated and was placed back in service on: (date)\_\_\_\_\_

The projected service life from the applicable date above is: (years)\_\_\_\_\_

Based on available records:

Are there any project records on file from the 2-year period preceding this review date that:

- records a serious event that could impact the condition of the structure?  
( Yes / No )
- records an operational problem that could impact the condition of the structure? (Yes / No )

Are there recent inspections records on file and available? (by type)

Level II Inspection: ( Yes / No ). If Yes, date of inspection record? (date)\_\_\_\_\_

Lowest condition rating of any distress?  
( Good / Marginal / Poor ) on (distress)\_\_\_\_\_

Level III Inspection: ( Yes / No ). If Yes, date of inspection record? (date)\_\_\_\_\_

Overall CI rating? (#)\_\_\_\_\_

Lowest individual CI of any distress? (#)\_\_\_\_\_ on (distress)\_\_\_\_\_

Engineering report: ( Yes / No ), If Yes, date of report record?  
(date)\_\_\_\_\_

Name of report or primary content? \_\_\_\_\_

Criteria to determine if the qualifications of a Level I Condition Assessment are met:

Answer the following questions based on the information given above.  
Place a check mark in the appropriate column. A checkmark in the second column disqualifies Level I review.

Criteria for Review	Level I Condition Assessment OK	Does Not Meet Level I Criteria Condition
If "No" to a record of a serious event in last 2 years, then LI OK	<input type="checkbox"/>	<input type="checkbox"/>
If "No" to a record of an operational problem in the last 2 years, then LI OK	<input type="checkbox"/>	<input type="checkbox"/>
If Level II inspection on file within the last 3 years and all condition ratings are "Good" or better, then LI OK <u>OR</u> If Level III inspection on file within the last 3 years and all condition index ratings are CI = 70 or higher, then LI OK <u>OR</u> If an engineering report is on file within the last 3 years and all applicable condition ratings are acceptable, then LI OK	<input type="checkbox"/>	<input type="checkbox"/>
If the structure is new and has not yet reached 1/4 of its projected service life, then LI OK	<input type="checkbox"/>	<input type="checkbox"/>
If the structure was recently rehabilitated and has not yet reached the 10th year since the rehab work, then LI OK	<input type="checkbox"/>	<input type="checkbox"/>

☐ This project meets the criteria for Level I Condition Assessment and does not require field inspection at this time.

Or

☐ This project does not meet the criteria for Level I Condition Assessment and must be reviewed for a Level II or Level III inspection recommendation.



Criteria to determine if a Level II or Level III inspection level is recommended:

Answer the following questions based on the information given above. Place a check mark in the appropriate column. A checkmark in the second column disqualifies a Level II inspection.

Criteria for review	Level II Inspection is recommended	Level III Inspection is recommended
If Level II inspection on file within the last 3 years and the majority of all condition ratings are "Good" or better, then Level II OK <b>OR</b> If Level III inspection on file within the last 3 years and all condition index ratings are CI = 55 or higher, then Level II OK	<input type="checkbox"/>	Not applicable
If Level II inspection on file within the last 3 years and the majority of all condition ratings are "Marginal", then Level III is required <b>OR</b> If Level III inspection on file within the last 3 years and the majority of all condition index ratings are CI = 70 or lower, then Level III is required	Not applicable	<input type="checkbox"/>
If the structure has now reached 1/3 (but less than 2/3) of its projected service life, then Level II is required	<input type="checkbox"/>	Not applicable
If the structure has now reached 2/3 of its projected service life without a Level III inspection, then Level III is required	Not applicable	<input type="checkbox"/>
If the structure was recently rehabilitated and has now reached the 10th year since the rehab work, then Level II is required	<input type="checkbox"/>	Not applicable
A period of at least 10 years has passed since the last Level II or Level III inspection, then Level II is required	<input type="checkbox"/>	Not applicable

☐ This project meets the criteria for a Level II inspection effort at this time.

Or

☐ This project meets the criteria for a Level III inspection effort at this time.

A Level IV inspection level is recommended IF any of the following criteria are met:

- A recent Level III CI inspection had an Overall Structure CI equal to 39 or lower. This re-inspection should occur within a maximum of 6 months.
- A recent Level III CI inspection had an Overall Structure CI in the Marginal range, 40 to 54 but an important individual component CI was less than 40. Engineering judgment will be applied in the review of the component distress to determine if a Level IV review is needed.
- The nature of the information required will not be produced by a lower level inspection; for example, a stress analysis of the lower section girder framing.

## Appendix E: Multi Level (II) Inspection of Miter Gates

*Lock & Dam Investigations, Inc., Ames, IA*  
*Dave McKay and Stuart Foltz (USACE/ERDC)*

The concept of the Level II condition inspection and evaluation is to make simple, checklist-type observations in the field that will allow a general condition assessment to be made and still be able to categorize the structure condition into quantifiable ranges of condition.

### The Inspection

Earlier research efforts have readily defined the lower boundary of acceptable condition for operating miter gates. In Level III terminology that would be  $CI = 40$ , the top edge of a condition category called Poor that describes conditions such as “serious deterioration” and “function is inadequate.” A Level II inspection should catch all defects before they reach that condition and should definitely not overlook defects that would fall into that category. The inspection questions are formulated in a way that any subjective query asks if a “Marginal” condition exists or presents a combination of queries that in total would sort out if a “Marginal” condition exists.

The inspection methodology borrows extensively from the REMR CI field practices and is structured to provide the baseline for the next level of inspection. Simplified CI or existing CI procedures comprise a Level III inspection. In fact, some of the observations are nearly the same; it is just the background interpretation of the field data that is different. The interpretation of the field data is related to, and dependent on, the context of the entire set of field data that is collected in an inspection procedure. The next section will address the use of the field data in condition assessment.

A Level II inspection for a miter gate set is structured to fit the instincts of an inspector as he or she first approaches the miter gate; that is, to first make an overall assessment of the gate, looking at those things that first catch your eye.

The [first page](#) of data is used to identify the project and structure, much like the existing inspection forms. The first page also focuses the inspectors' attention to a few details that provide the background criteria to assist in sorting out the correct forms for subsequent data collection. The information will also be used to categorize the overall structure condition into a quantifiable range of condition.

[Page 2](#) of the inspection form directs the attention to the first things that are noticed as the inspector approaches the gates: the condition of the walkway and handrails, the fender protection and the overall condition of the paint system on the gate. These are all items on which defects are generally cosmetic in nature. A significant difference between page two and the later inspection pages is that both the left and right gate leaves are recorded together, as a set, not individually. None of these items are taken into account in the Level III inspection procedure, as it is currently defined.

Pages [3](#), [4a](#), and [4b](#) of the inspection form directs attention to a critical element in the structural performance of the miter gate set, the bearing blocks. Page three covers bearing block observations and assessment for vertically framed miter gates and page four addresses horizontally framed miter gates. The two gate frame types have been separated to more easily focus the inspection questions and record direct data. The inspector would use one or the other of the bearing block forms on a miter gate set. Each page is used for only one gate leaf, that leaf being identified at the top of each page and collected together with the matching page for the opposing gate leaf. The data on these pages is collected throughout the inspection process: before gate operation with the gates in the recessed position, during filling and emptying of the lock chamber, and after full water pressure load has been applied.

[Page 5](#) contains two sections. The first section is the same procedure used in Level III inspection to assess gate noise, jump, and vibration (NJV) during gate movement. The second section is focused on the anchorages and gudgeon pin (hinge) assembly. This section contains questions similar to those that appear on the Level III inspection but are answered in Yes/No format and do not require measurements to be recorded. It is within the prerogative of the inspector to use devices such as a dial gauge to assist in determining the correct answer, but those data are not collected and stored.

[Page 6](#) provides the form for the inspector to log observations of apparent defects on the frame and skin plates of the miter gate set. The form is also setup to be gate leaf specific, using one form per gate leaf. The form is very much like the form proposed for use for Level III Simplified condition inspections and is also very similar to the inspection form presently in use to gather the same type of information. The form provides tables to log the presence of corrosion, cracks, leaks, boils, and dents as well as paint condition at the splash-zone. The tables provide column format to guide the inspector in quantifying a defect and identifying the defect location.

## **Condition Assessment**

It is recommended that a Level II inspection and assessment should be limited to the individual distress or defect that is being considered. It should not be combined into an overall condition assessment of the structure. Rather, the individual condition category rating would be used as a determinant for elevating the inspection intensity or effort to Level III.

A Level II rating is based on subjective data collection and does not provide the same level of confidence that condition assessment at Level III provides. It is therefore necessary to recognize that a Level II condition rating may be subject to a different interpretation of condition than the more detailed Level III methodology.

Any attempt to quantify condition needs to be made within the context of the REMR CI Scales and Zones set forth under earlier research efforts. This condition assessment scale provides the guideline for numerous other inspection and assessment methodologies at civil works structures.

## **Condition Assessment Rules**

The following collection of condition assessment rules is proposed for Level II.

The default condition rating is equal to Excellent for each distress unless modified by the rules defined for each distress.

***Walkways, Handrails, Fenders***

The original CI assessment rules did not cover these items. It is recommended that for each component on each gate leaf, the lowest subjective category be used to summarize the overall component rating. This rating is not used to trigger a Level III inspection.

***Paint***

The original CI assessment rules did not cover these items. It is recommended that for each component on each gate leaf, the lowest subjective category be used to summarize the overall component rating. This rating is not used to trigger a Level III inspection.

***Bearing Block Vertically Framed Gates***

The contact pattern selection would be used to set the condition rating at Excellent, Good, or Marginal.

A selection of “No Contact” for miter or quoin is equal to Poor.

A selection of “> 1/4 BW” for OFFSET is equal to Marginal.

A selection of “NO” for the question “Does miter or quoin gap close under full load?” is equal to Poor.

***Bearing Block Horizontally Framed Gates***

The contact pattern selection would be used to set the condition rating at Excellent, Good, or Marginal.

A selection of “> 1/8 BW” for OFFSET is equal to Marginal.

A selection of “YES” for the question “Does a leak follow...” for either the miter or quoin block would reduce the contact pattern rating by one level.

A selection of “YES” for the question “Does the gap between miter blocks change...” would reduce the contact pattern rating for miter block by one level. (Note: Only one rate step reduction is applied to miter block if both questions are answered “YES.”)

Recording any bearing block leak greater than 3 ft in length would reduce the contact pattern rating by one level. (Note: This rating step reduction is applied in addition to other rating modifiers.)

For bearing blocks, any condition rating of Marginal would trigger a Level III inspection at the next cycle and may suggest an expedited schedule. Any condition rating of Poor would dictate an immediate Level III inspection to verify condition.

### ***Noise Jump & Vibration (NJV) – Opening and closing of the gate leaf***

The questions and evaluation of condition is the same for Level III.

The question on diagonal flapping does not enter into the rating of NJV.

“Yes” for any one of the three questions equal a condition rating of Good.

“Yes” for any two of the three questions equal a condition rating of Marginal.

“Yes” for all three of the three questions equal a condition rating of Poor.

This is the same methodology for rating NJV as in Level III, but in Level III it can be used in ranking an overall gate rating.

### ***Anchorage Assembly***

Each anchorage arm, parallel or perpendicular, is evaluated independently and returns its own condition rating.

#### ***Anchorage Assembly at the Embedded Anchor***

“Yes” for any one of the three questions equal a condition rating of Good.

“Yes” for any two of the three questions equal a condition rating of Marginal.

“Yes” for all three of the three questions equal a condition rating of Poor.

#### ***Anchorage Assembly at the Anchor Pin and Linkage Arm***

“Yes” for the anchor pin question equal a condition rating of Good.

A selection of “YES” for the question “Does the movement...exceed 1/8 in.?” would reduce the rating for anchor pin by one level.

“Yes” for the linkage arm question equal a condition rating of Good.

A selection of “YES” for the question “Does the movement...exceed 1/8 in.?” would reduce the rating for linkage arm by one level.

### ***Anchorage Assembly at the Gudgeon Pin***

“Yes” for either, or both, of the gudgeon pin questions equals a condition rating of Good.

A selection of “YES” for the question “Does the movement...exceed 1/8 in.?” would reduce the rating for gudgeon pin by one level.

For the anchorage assembly, any condition rating of Marginal would trigger a Level III inspection at the next cycle and may suggest an expedited schedule. Any condition rating of Poor would dictate an immediate Level III inspection to verify condition.

### ***Corrosion***

Recording of critical corrosion is limited to the splash-zones. Even at that location, the corrosion level for skin plates and intercostals framing is not to be factored into condition rating.

A selection of “1/16 ft or <” for a girder is equal to Good.

A selection of “1/8 in. pit” for a girder is equal to Marginal.

A selection of “> 1/8 in. pit” for a girder is equal to Poor.

For corrosion, a condition rating of Marginal would trigger a Level III inspection at the next cycle and may suggest an expedited schedule. A condition rating of Poor would dictate an immediate Level III inspection to verify condition.

### ***Cracks***

Recording of any cracks in a Level II inspection would be cause for concern.



Any crack recorded in a girder is equal to Poor.

Multiple cracks in skin plate or intercostals framing up to a total of five is equal to Marginal.

Multiple cracks in skin plate or intercostals framing totaling six or more is equal to Poor.

For cracks, a condition rating of Marginal would trigger a Level III inspection at the next cycle and may suggest an expedited schedule. A condition rating of Poor would dictate an immediate Level III inspection to verify condition.

### ***Skin Leaks, Boil, and Dents***

These three defects do not significantly enter into condition rating at Level III so they are not viewed critically in Level II. Recording any occurrence of any of these defects is equal to Good.

## Multi-Level (II) Inspection Form for Miter Gates

NAME OF CIVIL WORKS PROJECT:

\_\_\_\_\_

LOCATION OF CIVIL WORKS PROJECT: (1. Body of water, 2. Nearest town)

1. \_\_\_\_\_

2. \_\_\_\_\_

INSPECTION DATE: \_\_\_\_\_ INSPECTED BY: \_\_\_\_\_

GATE IDENTIFICATION: ( Upper gate / Lower gate )

GATE STRUCTURAL FRAMING TYPE: ( Horizontal / Vertical )

TYPE OF SKIN PLATE: ( Single / Double )

LOCK CHAMBER SIZE: LENGTH (ft) \_\_\_\_\_ WIDTH (ft) \_\_\_\_\_

GATE LEAF DIMENSIONS: HEIGHT (ft) \_\_\_\_\_ WIDTH (ft) \_\_\_\_\_

LOCKMASTER COMMENTS: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

FACING DOWNSTREAM AT UPPER GATE, IDENTIFY LEAF AS LAND OR RIVER SIDE  
OF CHAMBER:

Left Gate Leaf = \_\_\_\_\_, Gate No: \_\_\_\_\_

Right Gate Leaf = \_\_\_\_\_, Gate No: \_\_\_\_\_

PROJECT: \_\_\_\_\_ Inspection Date: \_\_\_\_\_

**WALKWAY ON GATE LEAF AND CONDITION OF WALKWAY:**

**Gate Leaf   Grating Mat'l   Grating Type   Overall Condition**

**Left:**            (Steel/Aluminum) (Grating/Plate) (Excellent/Good/Marginal)

Transition to lockwall? (Excellent / Good / Marginal) Com-  
ment: \_\_\_\_\_

**Right:**        (Steel/Aluminum) (Grating/Plate) (Excel-  
lent/Good/Marginal)

Transition to lockwall? (Excellent / Good / Marginal) Com-  
ment: \_\_\_\_\_

**TYPE OF HANDRAIL ON GATE LEAF AND CONDITION OF HANDRAIL:**

**Gate Leaf   Rail Mat'l   Railing Type   Overall Condition**

**Left:**        (Steel/Aluminum)  
(Pipe/Pipe&Cable/Mesh) (Excellent/Good/Marginal)

Transition to lockwall? (Excellent/Good/Marginal) Com-  
ment: \_\_\_\_\_

Handrail attachment? (Secure/OK but Loose/Marginal)  
Comment: \_\_\_\_\_

**Right:**        (Steel/Aluminum)  
(Pipe/Pipe&Cable/Mesh) (Excellent/Good/Marginal)

Transition to lockwall? (Excellent/Good/Marginal)  
Comment: \_\_\_\_\_

Handrail attachment? (Secure/OK but Loose/Marginal)  
Comment: \_\_\_\_\_

TYPE OF FENDER PROTECTION AND CONDITION OF FENDERS:

Gate Leaf                      Fender Mat'l                      Overall Condition

**Left:**                      (Steel/Wood/Composition)                      (Excellent/Good/Marginal)

Fender attachment? (Secure/OK but Loose/Marginal)

Comment: \_\_\_\_\_

Damaged or missing fender?

Comment: \_\_\_\_\_

**Right:**                      (Steel/Wood/Composition)                      (Excellent/Good/Marginal)

Fender attachment? (Secure/OK but Loose/Marginal) Comment: \_\_\_\_\_

Damaged or missing fender? Comment: \_\_\_\_\_

GENERAL PAINT CONDITION OF GATE:

Type of paint system and last work: \_\_\_\_\_

GateLeaf Overall Condition: Excellent, Good, Marginal, Abraded, Flaking, Blisters

**Left:**

Girder: (US) \_\_\_\_\_ (DS) \_\_\_\_\_

Skin: (US) \_\_\_\_\_ (DS) \_\_\_\_\_

Intercostal: (US) \_\_\_\_\_ (DS) \_\_\_\_\_

**Right:**

Girder: (US) \_\_\_\_\_ (DS) \_\_\_\_\_

Skin: (US) \_\_\_\_\_ (DS) \_\_\_\_\_

Intercostal: (US)\_\_\_\_\_ (DS)\_\_\_\_\_

*(Note: Detail paint condition at splash-zones recorded later in form.)*

PROJECT: \_\_\_\_\_ Inspection Date: \_\_\_\_\_

**FACING DOWNSTREAM, IDENTIFY GATE LEAF:**


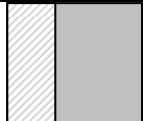

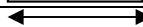
(LEFT or RIGHT), (UPPER or LOWER), GATE No: \_\_\_\_\_

**BEARING BLOCK OBSERVATIONS:**

**Vertically framed gates:**

**Miter end blocks**

Select the contact pattern that most correctly matches the apparent condition:

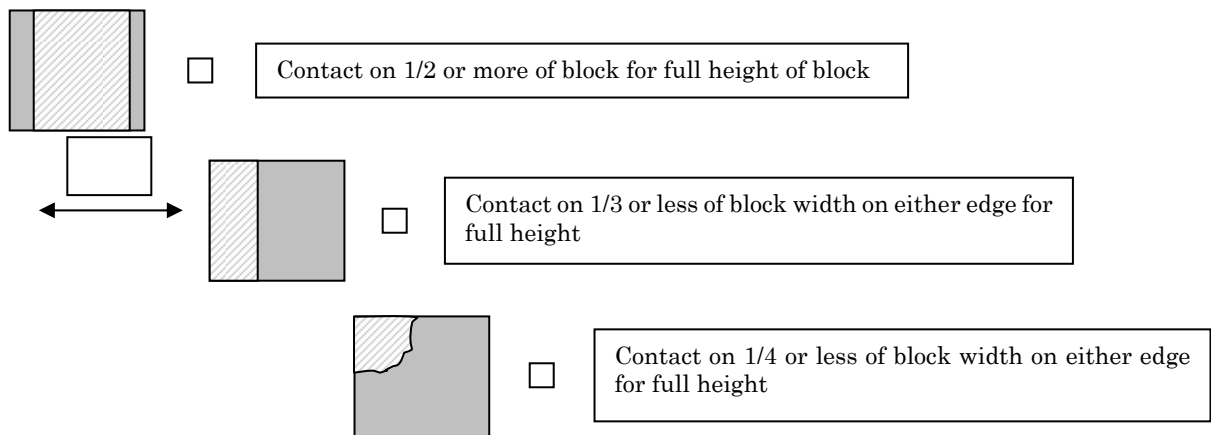
	<input type="checkbox"/>	Contact on 1/2 or more of block width for full height of block
	<input type="checkbox"/>	Contact on 1/3 or less of block width on either edge for full height(BW)
	<input type="checkbox"/>	Contact on any 1/4 quadrant of block but not full height
	<input type="checkbox"/>	No Contact anywhere on block

Is there OFFSET between the miter blocks when closed?(NONE/< 1/4 BW/  
> 1/4 BW)

(Note: 1/4 BW (block width) is approximately 2" to 2 1/2" offset)

Is there a gap between miter blocks when closed? 0, 1/8, 1/4, 3/8,  
1/2, > 1/2

Does the miter gap close under full load? ( YES / NO )

**Quoin end blocks**

Select the contact pattern that most correctly matches the apparent condition:

☐ No Contact anywhere on block

Is there a gap at the quoin block when closed? 0, 1/8, 1/4, 3/8, 1/2, > 1/2

Does the quoin block gap close under full load? ( YES / NO )

PROJECT: \_\_\_\_\_ Inspection Date: \_\_\_\_\_

**FACING DOWNSTREAM, IDENTIFY GATE LEAF:**

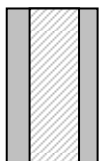
(LEFT or RIGHT), (UPPER or LOWER), GATE No: \_\_\_\_\_

**BEARING BLOCK OBSERVATIONS:**

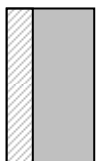
**Horizontally framed gates:**

**Miter end blocks**

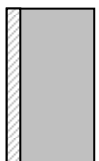
Select the contact pattern that most correctly matches the apparent condition:



Contact on 1/2 or more of block width for full exposed height (near center of block?)



Contact on 1/3 or more of block width on either edge for full height



Contact on 1/8 or more of block width on either edge for full height

Contact Patterns for bearing blocks:

Is there OFFSET between the miter blocks when closed? ( NONE  
/ < 1/8 BW / > 1/8 BW )

(Note: 1/8 BW (block width) is approximately 1" to 1 1/4" offset)

**During filling or emptying of the lock chamber:**



Does a leak follow the changing water level and then close?  
( YES / NO )

Does the gap between miter blocks change as the water load changes? ( YES / NO )

If yes, select from the following choices the most accurate description of the change ( circle choice ):

1. Top gap initially open but closes under full head.
2. Top gap opens wider but closes under full head.
3. Top gap opens and remains open.
4. Top of miter is closed but gap opens between water line and top.
5. Top of miter is closed and gap between water line and top closes.

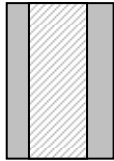
Estimate the maximum width of gap(in.): 0, 1/16, 1/8, 3/16, 1/4, 3/8, 1/2, > 1/2

Estimate the location of the maximum gap from top girder (ft): \_\_\_\_\_

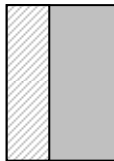
Does the gate vibrate? ( YES / NO )

### Quoin end blocks

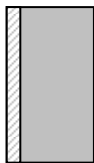
Select the contact pattern that most correctly matches the apparent condition:



Contact on 1/2 or more of block width for full exposed height (near center of block?) CI = 85



Contact on 1/3 or less of block width on either edge for full height CI = 70



Contact on 1/8 or less of block width on either edge for full height CI = 55

Contact Patterns for bearing blocks:

**After the gates are closed, but before any load is applied to the gate:**

Estimate the gap at the top of the quoin blocks? ( 0, < 1/8", > 1/8" )

**During filling or emptying of the lock chamber:**

Does a leak follow the changing water level and then close? (YES / NO )

PROJECT: \_\_\_\_\_ Inspection Date: \_\_\_\_\_

**FACING DOWNSTREAM, IDENTIFY GATE LEAF:**

(LEFT or RIGHT), (UPPER or LOWER), GATE No: \_\_\_\_\_

**OPENING AND CLOSING OF GATE LEAF:**

Ride the gate and record any occurrence and location of NJV:

%CLOSED (0 = Recessed, 100 = Mitered) Due to OE?

Do the diagonals flap? (YES / NO) 0 - - 20 - - 40 - - 60 - - 80 - - 100 (YES / NO)

Does the gate jump? (YES / NO) 0 - - 20 - - 40 - - 60 - - 80 - - 100 (YES / NO)

Is there gate noise? (YES / NO) 0 - - 20 - - 40 - - 60 - - 80 - - 100 (YES / NO)

Does the gate vibrate? (YES / NO) 0 - - 20 - - 40 - - 60 - - 80 - - 100 (YES / NO)

**OBSERVATIONS OF GATE ANCHORAGE AND FRAMING ASSEMBLIES FOLLOW:**

**ANCHORAGE ASSEMBLY OBSERVATIONS:**

(At the embedded anchor:)

Is the concrete wall cracked or spalled? Anchor corrosion? (Pits 1/8" Deep or >)

Parallel arm anchor: ( YES / NO ) Parallel arm: ( YES / NO )

Perp. arm anchor: ( YES / NO ) Perp. arm: ( YES / NO )

Is there evidence of past movement or is movement present during operations?

Parallel arm anchor: ( YES / NO ) Comment \_\_\_\_\_

Perp. arm anchor: ( YES / NO ) Comment \_\_\_\_\_

(At the anchor pin and linkage arm:)

Is there evidence the anchor pin moves or rotates?

Parallel arm anchor: ( YES / NO ) Comment \_\_\_\_\_

Does the movement appear to equal or exceed 1/8"? ( YES / NO )

Perp. arm anchor: ( YES / NO ) Comment \_\_\_\_\_

Does the movement appear to equal or exceed 1/8"? ( YES / NO )

Is there evidence of turnbuckle rotation or thread wear; or wedge pin movement?

Parallel arm linkage: ( YES / NO ) Comment \_\_\_\_\_

Does the movement appear to equal or exceed 1/8"? ( YES / NO )

Perp. arm linkage: ( YES / NO ) Comment \_\_\_\_\_

Does the movement appear to equal or exceed 1/8"? ( YES / NO )

(At the gudgeon pin:)

Is there evidence of gudgeon (hinge) pin movement or rotation?

At keeper bars or retainer plates? ( YES / NO )

At anchor yoke body to edge of gate frame? ( YES / NO )

Does the movement appear to equal or exceed 1/8"? ( YES / NO )

Comment

---



(Identify components by -- Girders (G), Skin plate (S), or Intercostals (I))

Bearing Block Leaks

	Location	Distance from top girder	Length
	<u>Quoin / Miter</u>	<u>down to top of leak (ft)</u>	<u>leak (ft)</u>
(1):	_____	_____	_____
(2):	_____	_____	_____
(3):	_____	_____	_____
(4):	_____	_____	_____

Skin Leaks (record leaks 1' or longer)

	Location, distance from:		
	<u>Length (ft)</u>	<u>Top girder (ft)</u>	<u>Quoin (ft)</u>
(1):	_____	_____	_____
(2):	_____	_____	_____
(3):	_____	_____	_____
(4):	_____	_____	_____

Boils (turbulence at DSWL) or Leaks at seals on exposed bottoms of gates

Type

	<u>Boil / Leak</u>	<u>Distance from quoin (ft)</u>
(1):	_____	_____
(2):	_____	_____
(3):	_____	_____
(4):	_____	_____

Dents

Component G, S or I	Side US or DS	Location, distance from:		Size (ft)		Critical Section?
		Top Girder (ft)	Quoin (ft)	Height	Width	
(1): _____	_____	_____	_____	_____	_____	YES / NO
(2): _____	_____	_____	_____	_____	_____	YES / NO
(3): _____	_____	_____	_____	_____	_____	YES / NO
(4): _____	_____	_____	_____	_____	_____	YES / NO

Comments: \_\_\_\_\_

\_\_\_\_\_

## Appendix F: Multi-Level (II) Inspection of Tainter Dam and Lock Gates

*Lock & Dam Investigation Inc, Ames, IA, July 2001*  
*David T. McKay and Stuart D. Foltz, ERDC/CERL, 2002*

The concept of the Level II condition inspection and evaluation is to make simple, checklist-type observations in the field that will allow a general condition assessment to be made and still be able to categorize the structure condition into quantifiable ranges of condition.

### The Inspection

Earlier research efforts have readily defined the lower boundary of acceptable condition for operating tainter dam and lock gates. In Level III terminology that would be  $CI = 40$ , the top edge of a condition category called Poor that describes conditions such as “serious deterioration” and “function is inadequate.” A Level II inspection should catch all defects before they reach that condition and should definitely not overlook defects that would fall into that category. The inspection questions are formulated in a way that any subjective query asks if a “Marginal” condition exists or presents a combination of queries that in total would sort out if a “Marginal” condition exists.

The inspection methodology borrows extensively from the REMR Condition Index field practices and is structured to provide the baseline for the next level of inspection. Simplified CI or existing CI procedures comprise a Level III inspection. In fact, some of the observations are nearly the same; it is just the background interpretation of the field data that is different. The interpretation of the field data is related to, and dependent on the context of the entire set of field data that is collected in an inspection procedure. The next section will address the use of the field data in condition assessment.

A Level II inspection for a tainter dam and lock gate set is structured to fit the instincts of an inspector as he or she first approaches the tainter gate; that is, to first make an overall assessment of the gate, looking at those things that first catch your



eye. The inspector will also complete this inspection from the normal service walkway for the dam gates or from the top of an adjacent lockwall in the case of a lock gate.

The [first page](#) of data is used to identify the project and structure, much like the existing inspection forms. The first page also focuses the inspectors' attention to a few details that provide the background criteria to assist in sorting out the correct forms for subsequent data collection. The information will also be used to categorize the overall structure condition into a quantifiable range of condition.

[Page 2](#) of the inspection form directs the attention to the first things that are noticed as the inspector approaches the gates, most noticeably the overall condition of the paint system on the gate. Paint is an item on which defects are generally cosmetic in nature. This item is not taken into account in the Level III inspection procedure, as it is currently defined.

Next, attention is focused on how well the gate appears to fit the gate bay opening (misalignment) and also how well the gate operates in the initial operating range as the gate is lifted to a nominal 2-ft gate opening (noise, jump, and vibration). Questions are similar to those that appear on the Level III inspection but are answered in Yes/No format and do not require measurements to be recorded.

Page [3](#) is focused on the anchorages and trunnion (hinge) assembly. This section contains questions similar to those that appear on the Level III inspection but are answered in Yes/No format or by simple observations that do not require accurate measurements.

The bottom of page 3 and continuing to [page 4](#) provides the form for the inspector to log observations of apparent defects on the frame and skin plates of the tainter dam and lock gate. The form is very much like the form proposed for use for Level III Simplified condition inspections and is also very similar to the inspection form presently in use to gather the same type of information. The form provides tables to log the presence of corrosion, cracks, leaks, and dents. The tables provide column format to guide the inspector in quantifying a defect and identifying the defect location.

## Condition Assessment

It is recommended that a Level II inspection and assessment should be limited to the individual distress or defect that is being considered. It should not be combined with an overall condition assessment of the structure. Rather, the individual condition category rating would be used as a determinant for elevating the inspection intensity or effort to Level III.

A Level II rating is based on subjective data collection and does not provide the same level of confidence that condition assessment at Level III provides. It is therefore necessary to recognize that a Level II condition rating may be subject to a different interpretation of condition than the more detailed Level III methodology.

Any attempt to quantify condition needs to be made within the context of the REMR CI Scales and Zones set forth under earlier research efforts. This condition assessment scale provides the guideline for numerous other inspection and assessment methodologies at civil works structures.

## Condition Assessment Rules

The following collection of condition assessment rules is proposed for Level II. The default condition rating is equal to Excellent for each distress unless modified by the rules defined for each distress.

### ***Paint***

The original CI assessment rules did not cover these items. For each component on each gate leaf, the lowest subjective category should be used to summarize the overall component rating. This rating is not used to trigger a Level III inspection.

### ***Noise Jump & Vibration (NJV) – Opening and closing of the gate leaf***

The questions and evaluation of condition is the same as for Level III.

The question on diagonal flapping does not enter into the rating of NJV.

- “Yes” for any one of the three questions equals a condition rating of Good.
- “Yes” for any two of the three questions equals a condition rating of Marginal.

- “Yes” for all three of the three questions equals a condition rating of Poor.

This is the same methodology for rating NJV as in Level III, but in Level III it can be used to calculate an overall gate rating.

### ***Vibration with Flow***

The questions and evaluation of condition is the same as for Level III.

- A selection of Level 2 or higher is equal to Good.
- A selection of Level 3 is equal to Marginal.
- A selection of Level 4 arm is equal to Poor.

This is the same methodology for rating Vibration with Flow as in Level III, but in Level III it can be used to calculate an overall gate rating.

### ***Anchorage Assembly***

Each anchorage assembly, left side or right side, is evaluated independently and returns its own condition rating.

At the embedded anchor:

- “Yes” for either one of the two questions regarding cracks in concrete base or pier equal a condition rating of Good. A “Yes” to the second follow-up question “Do cracks appear to be growing?” would reduce the condition rating to Marginal.
- “Yes” for any one of the three questions regarding bolts/nuts equal a condition rating of Good, but a “Yes” for any two of the three would reduce the condition rating to Marginal. A “Yes” for all three of the three questions equal a condition rating of Poor.
- A combination of a Marginal condition rating for both the cracks rating and the bolts/nuts rating would equal a condition rating for an anchorage assembly of Poor.

For the anchorage assembly, any condition rating of Marginal would trigger a Level III inspection at the next cycle and may suggest an expedited schedule. Any condition rating of Poor would dictate an immediate Level III inspection to verify condition.

### **Trunnion Assembly Wear**

At open end pin / bushing configuration:

- “Yes” for the lubrication system question or the grease expulsion question equals a condition rating of Good.
- “Yes” for the bushing shell question equals a condition rating of Marginal.
- “Yes” for the bushing is rotating question equals a condition rating of Poor.

At closed end bracket type configuration:

- “Yes” for the lubrication system question or the grease expulsion question equal a condition rating of Good.
- “Yes” for the bushing shell question equal a condition rating of Marginal.
- “Yes” for the bushing is rotating question equals a condition rating of Poor.

Lateral Movement for either trunnion configuration:

- “Yes” for the movement at the trunnion hub question equals a rating of Good.
- “Yes” for the excessive movement or damaging question equals a condition rating of Marginal.
- “Yes” for the excessive movement or damaging question and the gouging question equals a condition rating of Poor.

For the trunnion assembly, any condition rating of Marginal would trigger a Level III inspection at the next cycle and may suggest an expedited schedule. Any condition rating of Poor would dictate an immediate Level III inspection to verify condition.

### ***Corrosion***

Recording of critical corrosion is limited to major components. The corrosion level for skin plates and intercostals framing is not to be factored into condition rating.

- A selection of “1/16 ft or <” for a girder, trunnion assembly of a strut arm is equal to Good.
- A selection of “1/8 in. pit” for a girder, trunnion assembly of a strut arm is equal to Marginal.
- A selection of “> 1/8 in. pit” for a girder, trunnion assembly of a strut arm is equal to Poor.

For corrosion, a condition rating of Marginal would trigger a Level III inspection at the next cycle and may suggest an expedited schedule. A condition rating of Poor would dictate an immediate Level III inspection to verify condition.

### ***Cracks***

Recording of any cracks in a Level II inspection would be cause for concern.

- Any crack recorded in a girder, strut arm or trunnion part is equal to Poor.
- Multiple cracks in skin plate or other framing up to a total of three is equal to Marginal.
- Multiple cracks in skin plate or other framing totaling four or more is equal to Poor.

For cracks, a condition rating of Marginal would trigger a Level III inspection at the next cycle and may suggest an expedited schedule. A condition rating of Poor would dictate an immediate Level III inspection to verify condition.

### ***Leaks, Dents, and Seals***

These defects do not significantly enter into condition rating at Level III, so they are not viewed critically in Level II.

- Recording any occurrence of any of these defects is equal to Good.
- Any dent on a major component is equal to Marginal.
- Leaks, in combination with missing seals on a power plant project, are equal to Marginal.

**Multi-Level (II) Inspection Form for Tainter Dam and Lock Gates**

NAME OF CIVIL WORKS PROJECT:

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LOCATION OF CIVIL WORKS PROJECT: (1. Body of water, 2. Nearest town)

1. \_\_\_\_\_

2. \_\_\_\_\_

INSPECTION DATE: \_\_\_\_\_ INSPECTED BY: \_\_\_\_\_

FUNCTION AND LOCATION OF GATE: ( DAM / LOCK )

TYPE OF PROJECT: ( POWERPLANT / NON-POWERPLANT )

TYPE OF GATE: ( SUBMERSIBLE / NON-SUBMERSIBLE )

TYPE OF SKIN PLATE: ( SINGLE / DOUBLE )

TYPE OF LIFTING SYSTEM: ( CHAIN / CABLE )

GATE WIDTH: (ft) \_\_\_\_\_ GATE HEIGHT: (ft) \_\_\_\_\_

UPPER POOL: (ft) \_\_\_\_\_ LOWER POOL: (ft) \_\_\_\_\_

ELEVATION OF SILL: (ft) \_\_\_\_\_

DO YOU ROUTINELY BULKHEAD THE GATE? ( Y / N )

INTERVAL PERIOD? \_\_\_\_\_

WHAT YEAR WAS THE GATE LAST BULKHEADED? \_\_\_\_\_

LOCKMASTER COMMENTS :

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(FACE DOWNSTREAM TO DETERMINE LEFT OR RIGHT SIDE)

**GENERAL PAINT CONDITION OF GATE:**

Type of paint system and last work: \_\_\_\_\_

Gate Leaf\_ Overall Cond'n: Excellent, Good, Marginal, Abraded, Flaking, Blisters

Girders & Strut Arms: (DS) \_\_\_\_\_

Ribs & Bracing:

(DS) \_\_\_\_\_

Skin Plate: (US) \_\_\_\_\_

(DS) \_\_\_\_\_

**MISALIGNMENT**

IN THE LAST 12 MONTHS, WAS GATE OPERATED THROUGH A LIFT

CYCLE THAT WAS AT LEAST 75% OF THE GATES MAX. TRAVEL? ( Y / N )

IF NO, WAS IT BECAUSE: (CHECK APPLICABLE REASON)

☐ THE LIFT RANGE WAS LESS THAN 75%, OR

☐ THE GATE WAS NOT OPERATED IN THE LAST 12 MONTHS

WAS THERE EVIDENCE OF BINDING IN ANY PART OF THE GATE LIFT? (Y / N)

IF YES, WAS THE GATE LIFT STOPPED AT THAT POINT? ( Y / N )

IF YES, DOES IT LOOK LIKE FULL TRAVEL COULD BE POSSIBLE WITH GATE  
ADJUSTMENTS? DESCRIBE: \_\_\_\_\_  
\_\_\_\_\_

IS THERE ANY EVIDENCE ON THE PIER FACE OR ON THE SEALING SURFACE OF:

GOUGING? ( Y / N ), PIER FACE ( Left / Right ), DESC. \_\_\_\_\_

BINDING? ( Y / N ), PIER FACE ( Left / Right ),DESC.\_\_\_\_\_

DETERIORATION? ( Y / N ), PIER FACE ( Left / Right ),DESC.\_\_\_\_\_

Comments:

\_\_\_\_\_

**OPENING AND CLOSING OF THE GATE**

IS IT NORMAL OR DUE TO OE?

NOISE? ( Y / N )

( Y / N )

JUMPING? ( Y / N )

( Y / N )

VIBRATION? ( Y / N )

( Y / N )

Comments:

\_\_\_\_\_

**VIBRATION WITH FLOW**

GATE VIBRATION (LEVEL 0, 1, 2, 3, or 4): \_\_\_\_\_

CAN VIBRATION BE ELIMINATED BY GATE ADJUSTMENT? ( Y / N )

Comments:

\_\_\_\_\_

(FACE DOWNSTREAM TO DETERMINE LEFT OR RIGHT SIDE)

<b><u>ANCHORAGE ASSEMBLY DETERIORATION:</u></b>	<b><u>LEFT SIDE</u></b>	<b><u>RIGHT SIDE</u></b>
IS CONCRETE CRACKED OR SPALLED AT BASE?	Y / N	Y / N
ARE THE BOLTS/NUTS AT BASE: CORRODED?	Y / N	Y / N
LOOSE?	Y / N	Y / N
MISSING?	Y / N	Y / N
ARE CRACKS IN PIER EXTENDING TO ANCHOR ZONE?	Y / N	Y / N
FROM RECORDS, DO CRACKS APPEAR TO BE GROWING?	Y / N	Y / N
IS THERE EVIDENCE OF PAST MOVEMENT OR IS	Y / N	Y / N
MOVEMENT PRESENT DURING OPERATION?		

Comments:

---

**TRUNNION ASSEMBLY WEAR**

THE TRUNNION ASSEMBLY IS

1) AN OPEN END PIN / BUSHING CONFIGURATION

2) A CLOSED END BRACKET TYPE CONFIGURATION

	<b><u>LEFT SIDE</u></b>	<b><u>RIGHT SIDE</u></b>
ANY PROBLEMS WITH THE LUBRICATION SYSTEM?	Y / N / NA	Y / N / NA
IS THERE EVIDENCE OF TRUNNION WEAR?		

- GREASE EXPULSION IS UNEVEN OR THE ( Y / N ) ( Y / N )

PATTERN IS NOT LIKE SIMILAR TRUNNIONS

- THE BUSHING IS ROTATING OR TURNED ( Y / N ) ( Y / N )

- THE BUSHING SHELL THICKNESS APPEARS

TO VARY IN AREAS SUBJECT TO LOAD ( Y / N ) ( Y / N )

LATERAL MOVEMENT:

LEFT SIDE

RIGHT SIDE

IS THERE LATERAL MVM'T AT TRUNNION HUB? ( Y / N ) ( Y / N )

IS THE MOVEMENT EXCESSIVE OR DAMAGING? ( Y / N ) ( Y / N )

IS ANY GOUGING NOTICEABLE? ( Y / N ) ( Y / N )

CORROSION

(CONSIDER AVERAGE PIT DEPTH OVER MAJORITY OF COMPONENT, NOT A SINGLE LOCAL AREA)

COMPONENTS Level

GIRDERS ( None, 1/16"or less, 1/8" pit, > 1/8" pit )

STRUT ARMS ( None, 1/16"or less, 1/8" pit, > 1/8" pit )

TRUNNION GIRDER ( None, 1/16"or less, 1/8" pit, > 1/8" pit )

TRUNNION HUB ( None, 1/16"or less, 1/8" pit, > 1/8" pit )

TRUNNION YOKE ( None, 1/16"or less, 1/8" pit, > 1/8" pit )

Are there any other locations with severe corrosion?

\_\_\_\_\_  
\_\_\_\_\_

CRACKS: (RECORD COMPONENT, LENGTH, AND LOCATION)

MAJOR COMPONENTS: MAIN GIRDERS (M), STRUT ARMS (S), TRUNNION GIRDER (G), TRUNNION HUB (H), TRUNNION YOKE (Y),

MINOR COMPONENTS: RIBS (R), BRACING (B), SKIN PLATE (US) or (DS)

	<u>COMPONENT</u>	<u>LENGTH (in)</u>	<u>LOCATION</u>
(1):	_____	_____	_____
(2):	_____	_____	_____
(3):	_____	_____	_____
(4):	_____	_____	_____

**DENTS**: (RECORD COMPONENT, LENGTH OF DENT AND OUT OF PLANE DISTANCE)

MAJOR COMPONENTS: MAIN GIRDERS (M), STRUT ARMS (S)

	<u>COMPONENT</u>	<u>LENGTH OF DENT (in.)</u>	<u>OUT OF PLANE DISTANCE (in.)</u>	<u>LOCATION</u>
(1):	_____	_____	_____	_____
(2):	_____	_____	_____	_____
(3):	_____	_____	_____	_____
(4):	_____	_____	_____	_____

**LEAKS**: (RECORD TYPE, LENGTH, AND LOCATION)

TYPE: BOTTOM (B), LEFT (L), RIGHT (R)

	<u>TYPE: (B,L,R)</u>	<u>LENGTH (in.)</u>	<u>DISTANCE FROM TOP/LEFT (ft)</u>
(1):	_____	_____	_____

(2): \_\_\_\_\_

(3): \_\_\_\_\_

(4): \_\_\_\_\_

(5): \_\_\_\_\_

#### SEAL CONDITION

(RECORD LENGTH AND LOCATION OF DAMAGED(D) AND MISSING(M) SECTIONS)

LOCATION: BOTTOM (B), LEFT (L), RIGHT (R)

COND'N(D,M)    LOC'N(B,L,R)    LENGTH(in.)    DIST FROM TOP/LEFT(ft)

(1): \_\_\_\_\_

(2): \_\_\_\_\_

(3): \_\_\_\_\_

(4): \_\_\_\_\_

HOW MANY (IF ANY) SEAL BOLTS ARE MISSING? (no.) \_\_\_\_\_

## **Appendix G: Simplified Inspection Checklists**

**Operational Components**

**Electrical Components**

**Mechanical Components**

**Civil/Structural Components**

NOTE: Access to Appendix G is limited to U.S. Government agencies only. Authorized users may obtain a copy of this appendix from CEERD-CF-F, PO Box 9005, Champaign, IL 61826-9005.





## Appendix H: SWD Work Package Prioritization Criteria Matrices

Risk Assessment Matrix 1 MISSION IMPACT		Severity of Consequences if work NOT performed		
		HIGH	MEDIUM	LOW
Probability/likelihood of impact to any business function if work NOT performed	HIGH	100	75	50
	LOW	75	50	25
Negligible or no impact/not applicable		0	0	0
Probability/likelihood of impact to any business function if work NOT performed during the Budget Year (BY)		Severity of Consequences if work NOT performed during the BY		
Level: High Description: System, navigation reach, or component failure by end of BY.		Category: High Description: Catastrophic Definition: Loss or significant damage to system, equipment, facilities, item, public property, navigation reach, etc. Severely or totally restricts operations for Business Function/Mission/Project Purpose.		
Level: Low Description: Remote chance of failure by end of BY.		Category: Medium Description: Critical Definition: Moderate damage to system, equipment, facilities, item, public property, navigation reach, etc. Moderate restrictions to operations for Business Function/Mission/Project Purpose.		
		Category: Low Description: Marginal Definition: Minimal, if any, damage to system, equipment, facilities, item, public property, navigation reach, etc. Minimal, if any, restrictions to operations for Business Function/Mission/Project Purpose.		

<b>Risk Assessment Matrix 2 CUSTOMER IMPACT</b>		<b>Severity of Impact if work NOT performed</b>		
		<b>HIGH</b>	<b>MEDIUM</b>	<b>LOW</b>
Probability/likelihood of affecting customer if work NOT performed	HIGH	100	75	50
	LOW	75	50	25
Negligible or no impact/not applicable		0	0	0
<b>Probability/likelihood of affecting customer if work NOT performed during the BY</b>		<b>Severity of Impact if work NOT performed during the BY</b>		
Level: High Description: Highly likely to have an impact on the customer before end of BY.		Category: High Description: Catastrophic Definition: If work not performed in the BY, condition of the system or component will prevent use of the project or facility and/or will inflict severe impacts (i.e. economic, environmental, safety or convenience) on the customer (user).		
Level: Low Description: Unlikely, but possible, to have an impact on the customer before end of BY.		Category: Medium Description: Critical Definition: If work not performed in the BY, condition of the system or component will limit use of the project or facility and/or will impose impacts (i.e. economic, environmental, safety or convenience) on the customer (user).		
		Category: Low Description: Marginal Definition: If work not performed in the BY, condition of the system or component may limit use of the project or facility and/or may impose impacts (i.e. economic, environmental, safety or convenience) on the customer (user)		

Risk Assessment Matrix 3 FEDERAL REVENUE GENERATION		Magnitude of increase if work IS performed		
		HIGH	MEDIUM	LOW
Probability/likelihood of increasing Federal revenue if work IS performed	HIGH	100	75	50
	LOW	75	50	25
Negligible or no increase/not applicable		0	0	0
<b>Probability/likelihood of in- creasing Federal revenue if work IS performed during the BY</b>		<b>Magnitude of increase if work IS performed during the BY</b>		
Level: High Description: Revenue increase predicted.		Category: High Description: Significant increase in revenue or prevention of sig- nificant loss of revenue. Return of investment in less than 10 years.		
Level: Low Description: Remote chance of revenue increase.		Category: Medium Description: Moderate increase in revenue or prevention of mod- erate loss of revenue. Return of investment in less than 10 years.		
		Category: Low Description: Marginal, if any, increase in revenue or prevention of marginal loss of revenue. Maintain current level of income.		

Risk Assessment Matrix 4 REDUCTION OF FUTURE O&M COSTS		Relationship of cost of work to savings over next 5 years		
		HIGH	MEDIUM	LOW
How fast is problem getting worse? (High - Accelerated Rate; Low - Steady Rate)	HIGH	100	75	50
	LOW	75	50	25
Negligible/not applicable/no increase		0	0	0
How fast is problem getting worse?		Relationship of cost of work to savings over next 5 years		
<i>Level: High</i> <i>Description: The problem is getting worse at an accelerated rate.</i>		<i>Category: High</i> <i>Description: The cost of the work package is less than the savings realized in the next 5 years and/or the <u>nature</u> of the work item will change to replacement of structural members/facilities/equipment in 1 year.</i>		
<i>Level: Low</i> <i>Description: The problem is getting worse at an steady rate.</i>		<i>Category: Medium</i> <i>Description: The cost of the work package is equal to the savings realized in the next 5 years and/or the <u>nature</u> of the work item will change to replacement of structural members/facilities/equipment in 2-3 years.</i>		
		<i>Category: Low</i> <i>Description: The cost of the work package is greater than the savings realized in the next 5 years and/or the <u>nature</u> of the work item will change to replacement of structural members/facilities/equipment in 3-4 years.</i>		

Risk Assessment Matrix 5 PUBLIC RELATIONS	Degree of interest in work to be performed		
	HIGH	MEDIUM	LOW
	100	50	25
Negligible or no interest/not	0	0	0

applicable			
	<b>Degree of interest in work to be performed</b>		
	<p>Category: High Description: Level of interest is from a National perspective. Interest has been shown from the President or the Congress. Definition: Letter from President or Congressional delegation expressing specific interest in the subject work or Congressional delegation members have met with District Staff.</p>		
	<p>Category: Medium Description: Level of interest is from a State perspective. Interest has been shown from the Governor, State Senators, or State Representatives. Definition: Governor, State Senators, or State Representatives have written letters or met with the District Staff expressing a specific interest in the subject work. State Staffers have inquired into and expressed the view that the members of the delegation are interested in the subject work.</p>		
	<p>Category: Low Description: Level of interest is from a local perspective. Interest has been shown from Bass Clubs, Marina Operator Associations, County Judges or other County Officials, Mayors, Conservation organizations, local groups or individuals. Definition: Bass Clubs, Marina Operator Associations, County Judges or Officials, Mayors, Conservation organizations, local groups or individuals have met with District Staff expressing a specific interest in the subject work. Significant numbers of letters have been received from the above-described organizations or individuals expressing a specific interest in the subject work.</p>		

<b>Risk Assessment Matrix 6 NON-CORPS COMPLIANCE ISSUES</b>	<b>Degree of interest in work to be performed</b>		
	<b>HIGH</b>	<b>MEDIUM</b>	<b>LOW</b>
	100	50	25
No issues/not applicable	0	0	0
	<b>Degree of interest in work to be performed</b>		
	<p>Category: High Description: Noncompliant and a notification of non-compliance is expected. Definition: A high rating results when an EIS, EA or inspection report identifies the subject work to be performed as needed due to noncompliance with regulation or law and the project will be subjected to legal action and/or fines.</p>		

	<p>Category: Medium</p> <p>Description: Noncompliant but notification of noncompliance is not expected.</p> <p>Definition: A medium rating results when an EIS, EA, or inspection report identifies the subject work to be performed as needed due to noncompliance with regulation or law but the project will not be subjected to legal action and/or fines.</p>
	<p>Category: Low</p> <p>Description: In compliance but the potential exists for non-compliance in the BY+1 or beyond.</p> <p>Definition: A low rating results when an EIS, EA, or inspection report indicates compliance with regulation or law, but the potential exists for noncompliance in the BY+1 or beyond.</p>

Risk Assessment Matrix 7 SAFETY	Severity of consequences if work <u>NOT</u> performed				
	HIGH	MEDIUM	LOW		NEGLIG
Probability of adverse impact if work <u>NOT</u> performed	HIGH	100	100	80	60
	MED HIGH	100	80	60	40
	MEDIUM	80	60	40	20
	LOW	60	40	20	10
	NEGLIG	40	20	10	0
Not applicable	0	0	0		0
Probability of adverse impact if work <u>NOT</u> performed during the BY	Severity of consequences if work <u>NOT</u> performed during the BY				
Description: Frequent Level: High Individual Item: Likely to occur frequently in life of system, item, facility, etc.	Category: High Description: Catastrophic Definition: Death or permanent total disability, system loss, major property damage.				
Description: Probable Level: Medium High Individual Item: Will occur several times in the life of system, item, facility, etc.	Category: Medium Description: Critical Definition: Permanent partial disability or temporary total disability in excess of 3 months, major system damage, significant property damage.				
Description: Occasional Level: Medium Individual Item: Likely to occur sometime in the life of system, item, facility, etc.	Category: Low Description: Marginal Definition: Minor injury, lost workday accident, or compensable injury or illness, minor system damage, minor property damage.				
Description: Remote Level: Low	Category: Negligible Description: Negligible				

Individual Item: Unlikely but possible to occur sometime in the life of system, item, facility, etc.	Definition: First aid or minor supportive medical treatment, minor system impairment
Description: Improbable Level: Negligible Individual Item: So unlikely it can be assumed that occurrence may not be experienced in the life of system, item, facility, etc.	

## SWD Criteria Definitions

(Does not include definitions for Criteria 1 or 3)

### SWD FY 02 O&M Budget Prioritization Criteria

#### Definitions and Examples

#### 2. Customer Impact

a. Definition. This criterion identifies the importance of funding the proposed work during the Budget Year (BY) and the impact upon the customer that attempts to utilize one or more project features. The term “customer” is used to describe industry at large or private individuals outside the Federal Government. Impacts on the customer include situations that interfere with utilizing one or more of the purposes or features of the project; and/or having economic, environmental, safety or convenience consequences. The criterion also considers the degree of impact on the customer. A “HIGH” impact rating would indicate that customer is prevented from utilizing any of the project or its features; or being inflicted (forced) to encounter severe economic, environmental, safety or convenience impacts. A “MEDIUM” impact rating would indicate the customer has limited use of the project or its features or being imposed (burdened) with economic, environmental, safety or convenience impacts. A “LOW” impact rating would indicate the customer may or may not have limited use of the project or some of its features or may or may not encounter limited economic, environmental, safety or convenience impacts. A “NON-APPLICABLE” rating indicates no impact on the customer and receives the score of zero.

b. Examples of HIGH Impact:

- Not funding lock operations on the GIWW will result in a high probability of gate closure and result in complete shutdown to navigation.
- Not funding dredging of the GIWW or main harbor channels will permit severe shoaling in the channel resulting in severe safety and environmental risks (potential collision with consequent petrochemical spills, etc) as well as severe economic loss to users/customers.
- Not funding Flood Control operations on the Addicks/Barker Reservoir with result in severe property damages to down stream properties in Houston.

Examples of MEDIUM Impact:

- Not funding lock/floodgate repairs will result in continued degradation of the facility such that repair costs will increase substantially.
- Not funding dredging requirements will result minimal delays or economic loss to users/customers.

Examples of LOW Impact:

- Not funding dredging for advanced maintenance purposes, i.e., no shoaling or material exists in the dredging template that would interfere with vessel traffic.

4. Reduction of Future O&M Costs.

a. Definition. This criterion evaluates the savings of O&M dollars if the work package is performed now as compared to waiting in the future. It has two components. The first involves comparing the cost of the work package to savings realized (see worksheet) for 5 years. The second component involves preventative maintenance. Preventative maintenance is performed to prevent equipment/structures/facilities maintenance from growing to the point of requiring major work or maintenance. If preventative maintenance is not performed, cost of work required would be an order of magnitude greater and the nature of the work item would change from a purely “maintenance” item to a “fix or repair” item. The attached worksheet will help in your determination of reduction of O&M dollars.



b. Examples.

### Examples of Rating for Reduction of Future O&M Costs

Funding road repairs at a cost of \$300k will greatly reduce the maintenance required to keep the roads in passable condition. The work would result in annual savings of O&M costs of \$70k per year over the next 5 years, or \$350k total. These savings over a 5 year period are greater, the cost of the work package providing a **high** cost to savings relationship resulting in a **high** severity rating or if the nature of work would change from surface maintenance /repairs to include base or sub-base repairs.

Funding the replacement of a roof on a project office or powerhouse at a cost of \$125k will reduce frequent repairs to a leaking roof resulting in annual savings of \$25k per year over the next 5 years or \$125k total. These savings over the next 5 years is equal to the cost of the work package providing a **medium** cost to savings relationship resulting in a **medium** severity rating.

Funding the replacement of tainter gate hoisting cables at a cost of \$280k will result in annual savings of future O&M costs of \$10k per year over the next 5 years, or \$50k. This savings is less than the cost of the work package providing a **low** cost to savings relationship resulting in a **low** severity rating.

### Examples of Preventive Maintenance Items

If not funding a work package for painting of tainter gates in the BY results in having to also repair or replace structural members of the gates in addition to the painting, then the work package would be given a rating of **high** severity if the additional deterioration would occur in BY + 1 year. If the additional deterioration of gates would occur in BY + 2 to 3 years, then the work package would be given a rating of **medium** severity. If the additional deterioration would occur in BY + 3 to 4 years the work package would be given a rating of **low** severity.

If replacement of worn out OCBs at a powerhouse is not funded and the OCBs malfunction and fail to trip and disconnect during an event of a transformer current differential, the transformers will be severely damaged or destroyed.

Riprap repair on an embankment. If riprap is not repaired the problem could deteriorate into repairing erosion on the embankment plus the riprap. This is applicable to any erosion repair item, i.e., if there is erosion of shoreline that could be repaired with installation of erosion prevention measures, this would save us from major bank reestablishment, buying improvements on the property, etc.

## Reduction of Future O&M Costs Worksheet

### Part 1.

What is the cost of the work package? \_\_\_\_\_ (a)

How many O&M dollars are spent annually on this in its current condition?  
\_\_\_\_\_ (b)

How much O&M dollars would be spent on this annually if the work package was performed? \_\_\_\_\_ (c)

Savings realized in 5 years (d) = (b-c) x 5

Compare (d) to (a):

If (a) < (d), then HIGH

If (a) = (d), then MEDIUM

If (a) > (d), then LOW

### Part 2.

If Preventative Maintenance activity is not performed, at what point will the nature of the work item change to replacement of structural members/facilities/equipment?

1 year	2-3 years	3-5 years
HIGH	MEDIUM	LOW

Since this is an “and/or” situation, use the higher rating of the two parts for the matrix value.

## SWD FY 03 O&M Budget Prioritization Criteria

### Definitions and Examples

#### 1. Public Relations.

a. Definition. This criterion identifies whether, or to what degree, the proposed work has customer interest. A high rating results when the level of interest is from a **national** perspective (from the President, Senators or Congressmen/women). A medium rating results when the level of interest is from the **state** perspective (from the Governor, State Senators or State Representatives). A low rating results when the level of interest is from the **local** perspective (from Bass Clubs, Marina Operator Associations, County Judges or other County Officials, Mayors, Conservation organizations, local groups or individuals).

b. Examples. High – 100: The work identified by the work package has been the subject of several congressionals and/or a congressional staffer has contacted the Operations Manager and/or the Chief of Operations concerning the work.

Medium – 50: The work identified by the work package has been the subject of several meetings with the Governor and/or a State Representative has talked with the Chief of Operations about the work.

Low – 25: The work identified by the work package has been the subject of numerous phone calls with local Bass Clubs or local groups and several meeting with the county judge.

#### 6. Non-Corps Compliance Issues.

a. Definition. This criterion identifies whether, or to what degree, the proposed work is needed due to noncompliance of some non-Corps regulation or law. A high rating results when an EIS, EA or inspection report identifies the subject work to be performed as needed due to non-compliance with regulations or law and the project **will be subject to legal action** and/or fines. A medium rating results when an EIS, EA or inspection report identifies the subject work to be performed as needed due to non-compliance with regulations or law but the **project will not be subject to legal action** and/or fines. A low rating would result when an EIS, EA or inspection report identifies compliance with regulations or law, but the **potential exists for noncompliance** in the BY+1 or beyond.

b. Examples. High Rating – 100: The work identified by the work package will correct problems with the water system in Happy Park. The project has received a letter from the state environmental department stating that the water system in Happy Park is not in compliance with state requirements and if not corrected the state will take legal action and impose fines. The project has implemented temporary measures and submitted a plan for correcting the problem. The state has given the project until BY+1 to implement a permanent solution.

Medium Rating – 50: The work identified by the work package will restore a dredge disposal area in compliance with a permit from the US Fish & Wildlife Service. The project has a permit from the US Fish & Wildlife Service to dispose of dredge material in an area on a wildlife refuge. A condition of the permit is that an abandon disposal area will be restored in the BY+1. If the restoration is not performed the permit will be revoked.

Low Rating – 25: The work identified by the work package will correct a drainage problem at the project's marine terminal. An ERGO inspection identified a potential violation of state regulations in the BY+1 if the subject work is not performed.

## 7. **Safety.**

a. Definition. This criterion identifies the importance of accomplishing the proposed work in order to maintain a safe project environment applicable to personnel and property. Proposed work items that address a current hazard should be repaired immediately or alternative measures taken using available O&M funds. This criterion can be a documented safety problem resulting from an annual or periodic inspection report, dam safety assurance studies, engineering judgment, scheduled maintenance needs or viable concerns expressed by using interests, public or governmental entities and/or resource groups.

b. Examples. Not funding the riprap grouting at the recreation area adjacent to the stilling basin at JR reservoir has a rating of 40 with medium probability of adverse impacts and a low severity of consequence.

The spillway at reservoir X experienced erosion during the last significant rainfall presenting a safety risk to the urbanized areas located downstream. Preliminary investigations indicated the need for a dam safety study to evaluate the need to extend the spillway structure. The work package has a rating of 80 with medium probability of adverse impact and high severity of consequences for a high hazard

dam; a low hazard dam will yield a rating of 60 with medium probability of adverse impact and medium severity of consequence.

The road located on the dam crest, which also serves as a project access as well as locally used roadway, has developed potholes and longitudinal cracking due to foundation problems and rainwater seepage. The investigating officer attributed one minor traffic accident involving one vehicle to the dangerous condition of the roadway. Maintenance for the road is a government responsibility. This work package has a rating of 40 with low probability of adverse impact and medium severity of consequence.

The last periodic inspection at Lock and Dam X found excessive leakage into the lower inspection gallery. While sump pumps dewater the gallery the amount of flow will eventually cause the leakage to inundate the electric lighting causing a deadly hazard to the structure operators. This work package rates a score of 80 with a medium probability of impact and high severity of consequences.

Mowing and vegetation control efforts at recreation areas of Lock and Dam X need to be increased due to the documented incidents of snakebites and alligator attacks on the public and rangers. This work package has a rating of 80 with a medium-high probability of adverse impact and medium severity of consequence.

The elevator at the outlet works structure of Dam X has broken down, become unusable and is in need of repair. While access to the dry well is available through the stairwell, it is very difficult to carry heavy tools and replacement parts through a six-story climb presenting a safety hazard to the project operators. This work package has a rating of 20 with a low probability of adverse impact and low severity of consequence.

## Appendix I: LRD Work Package Prioritization Criteria Matrices

Risk Assessment Matrix MISSION ACCOMPLISHMENT		Severity of Consequences if work NOT performed		
		HIGH	MEDIUM	LOW
Probability of adverse impact if work NOT performed	HIGH	100	80	60
	MED	80	60	40
	LOW	60	40	20
Negligible / not applicable		0	0	0
<b>Probability / likelihood of adverse impact to mission if work NOT performed during the BY</b>		<b>Severity of Consequences if work NOT performed during the BY</b>		
Level: High Description: System/component expected to lose its ability to perform a portion(s) of the project purpose(s) in end of BY.		Category: High Description: Catastrophic Definition: Loss or significant damage to system, equipment, facilities, item, public property, navigation reach, etc. Severely or totally restricts operations for Business Function / Mission.		
Level: Medium Description: System/component could lose its ability to perform a portion(s) of the project purpose(s) in the BY.		Category: Medium Description: Critical Definition: Moderate damage to system, equipment, facilities, item, public property, navigation reach, etc. Moderate restrictions to operations for Business Function / Mission.		
Level: Low Description: System/component not expected to lose its ability to perform a portion(s) of the project purpose(s) in the BY.		Category: Low Description: Marginal Definition: Minimal, if any, damage to system, equipment, facilities, item, public property, navigation reach, etc. Minimal, if any, restrictions to operations for Business Function / C3Mission.		

Weight Factor = 0.25

Category: No Impact = 0 points

Risk Assessment Matrix CUSTOMER IMPACT		Severity of consequences if work NOT performed		
		HIGH	MEDIUM	LOW
Probability of adverse impact on the customer if work NOT performed	HIGH	100	80	60
	MED	80	60	40
	LOW	60	40	20
Negligible / not applicable		0	0	0
Probability / likelihood of adverse impact to the customer if work NOT performed during the BY		Severity of consequences if work NOT performed during the BY		
Level: High Description: Condition & function of project or component will prevent level of service expected by traditional customers in accordance with project purpose(s) in the BY.		Category: High Description: Catastrophic Definition: Significant Regional Impact (National)		
Level: Medium Description: Condition & function of project or component will limit level of service expected by traditional customers in accordance with project purpose(s) in the BY.		Category: Medium Description: Critical Definition: Moderate Regional Impact		
Level: Low Description: Condition & function of project or component may limit level of service expected by traditional customers in accordance with project purpose(s) in the BY.		Category: Low Description: Marginal Definition: Local Impact		

Weight Factor = 0.25

Category: No Impact = 0 points



Risk Assessment Matrix ECONOMIC BENEFITS		Level of benefits if work <u>IS</u> performed		
		HIGH	MEDIUM	LOW
Probability of benefits if work <u>IS</u> performed	HIGH	100	80	60
	MED	80	60	40
	LOW	60	40	20
Negligible / not applicable		0	0	0
Probability of benefits if work <u>IS</u> performed during the BY		Level of benefits		
Level: High Description: <u>Certain</u> that economic benefits as defined by Federal revenue generation, reduction of future O&M, or regional economic perspective will accrue through the performance of the work package over a time frame of BY + 5. - OR - Deterioration rate is increasing in excess of normal inflation rate increases.		Category: High Description: Net benefits or funds saved are valued at greater than \$150,000. Benefits are defined by Federal revenue generation, reduction of future O&M, or regional economic perspective.		
Level: Medium Description: <u>Expected</u> that economic benefits as defined by Federal revenue generation, reduction of future O&M, or regional economic perspective will accrue through the performance of the work package over a time frame of BY + 5. - OR - Deterioration rate is at a steady rate.		Category: Medium Description: Net benefits or funds saved are valued between \$150,000 and \$50,000. Benefits are defined by Federal revenue generation, reduction of future O&M, or regional economic perspective.		
Level: Low Description: <u>Possible</u> that economic benefits as defined by Federal revenue generation, reduction of future O&M, or regional economic perspective will accrue through the performance of the work package over a time frame of BY + 5. - OR - Deterioration warrants monitoring.		Category: Low Description: Net benefits or funds saved are valued at less than \$50,000. Benefits are defined by Federal revenue generation, reduction of future O&M, or regional economic perspective.		

Weight Factor = 0.20

Category: No Economic Impact = 0 points

Risk Assessment Matrix NON-CORPS COMPLIANCE ISSUES		Severity of consequences if work NOT performed		
		HIGH	MEDIUM	LOW
Probability of adverse impact if work NOT done	HIGH	100	80	60
	MED	80	60	40
	LOW	60	40	20
Negligible / not applicable		0	0	0
Probability / likelihood of adverse impact if work NOT performed during the BY		Severity of consequences if work NOT performed during the BY		
Level: High Description: Certain that official notification or knowledge of noncompliance will be received before the end of the budget year.		Category: High Definition: Noncompliance with Federal / State laws or regulations that may result in fines or other legal action.		
Level: Medium Description: Expected that official notification or knowledge of noncompliance will be received before the end of the budget year.		Category: Medium Definition: Agency/ public/ industry interest or pressure.		
Level: Low Description: Possible that official notification or knowledge of noncompliance will be received before the end of the budget year.		Category: Low Definition: Minimal interest or pressure.		

Weight Factor = 0.15

Category: No Impact = 0 points

Risk Assessment Matrix SAFETY		Severity of consequences if work <u>NOT</u> performed			
		HIGH	MEDIUM	LOW	NEG
Probability of adverse impact if work <u>NOT</u> performed	HIGH	100	100	80	60
	MED-HIGH	100	80	60	40
	MEDIUM	80	60	40	20
	MED-LOW	60	40	20	10
	LOW	40	20	10	0
Probability of adverse impact if work <u>NOT</u> performed during the BY		Severity of consequences if work <u>NOT</u> performed during the BY			
Description: Frequent Level: High Individual Item: Likely to occur frequently to the system, item, facility, etc.		Category: High Description: Catastrophic Definition: Death or permanent total disability, system loss, major property damage.			
Description: Probable Level: Medium High Individual Item: Will occur several times to the system, item, facility, etc.		Category: Medium Description: Critical Definition: Permanent partial disability or temporary total disability in excess of 3 months, major system damage, significant property damage.			
Description: Occasional Level: Medium Individual Item: Likely to occur sometime to the system, item, facility, etc.		Category: Low Description: Marginal Definition: Minor injury, lost workday accident, or compensable injury or illness, minor system damage, minor property damage.			
Description: Remote Level: Medium Low Individual Item: Unlikely but possible to occur to the system, item, facility, etc.		Category: Negligible Description: Negligible Definition: First aid or minor supportive medical treatment, minor system impairment.			
Description: Improbable Level: Low Individual Item: So unlikely it can be assumed occurrence may not be experienced to the system, item, facility, etc.					

Weight Factor = 0.15

9 January 2001

## LRD FY 02 O&M Budget Prioritization Criteria

### Revised Definitions and Examples

#### 1. **Mission Accomplishment.**

a. Definition. This criterion identifies the importance of accomplishing the proposed work in order for the project to perform its project purpose in the Budget Year. Most projects have numerous authorized purposes. For example, a reservoir has project purposes such as flood control, recreation (camping facilities and visitor centers), and possibly hydropower. A navigation lock site has project purposes of the lock passing vessels through it and of the dam to help control pool levels, both upstream and downstream. One component of this criterion is the probability or likelihood of adverse impact to the mission if the work is not funded. The adverse impact to the mission ranges from a high to a low level. A high level would indicate that, if the work is not funded, you would expect to lose the ability to perform some portion of the project purpose. A medium level means you could lose, while a low level means you would not expect to lose, the ability to perform some portion of the project purpose. The second component of this criterion relates to the severity of consequences if the work is not funded. The severity ranges from high to low. A high severity indicates that catastrophic loss or significant damage to some component of the project would severely or totally restrict project operations. A medium severity indicates a critical loss or moderate damage, while a low severity indicates a marginal loss or minimal damage, to some component of the project which would moderately or minimally, respectively, restrict project operations. A severity rating of zero indicates no impact on mission accomplishment.

#### b. Examples.

Not funding repairs to a miter gate will have a high probability that the gate will fail and become inoperable.

Not funding repairs to a breakwater pier will result in failure of a portion of the structure and cause stone to fall partway into the navigation channel, restricting traffic to one-way.

Not funding renovation to camp pads will have moderate impacts to campers due to the deteriorated condition of the pads.

Not funding the non-baseline maintenance replacement of a certain component of a generator will have no impacts to the plant operation, but will increase replacement costs if delayed.

Not funding road paving will create a loss of campground visitors and subsequent loss of revenue.

Not funding repairs to a storm damaged rubble mound breakwater will result in the failure of a portion of the structure and will severely restrict the use of the harbor by commercial shipping interests.

A section of harbor jetty, confirmed by an underwater investigation, is displaying signs of sub-structure failure. Not funding and initiating repairs in the BY could **(LOW)** result in failure of a portion of the structure and partially block the channel causing restrictions to vessels **(MEDIUM)**.

Three of five combination restroom/shower buildings at a 300-site campground are in deplorable condition according to inspection reports and customer comment cards. These facilities serve 200 campsites. They have experienced spot repairs and renovations over the past several years but are expected to be in such condition by the end of the budget year as to force facility closure. Reconstruction will cost \$550,000. The probability that these facilities will be closed and lose their ability to perform the recreation mission at this project is high. The severity of operational restrictions due to the closure of these facilities will be moderate. While a small portion of the campground may remain open, project visitation will be severely impacted.

61KV transformer cooling system at Barkley Dam and Barkley Lake

Lorain Harbor Dredging Commercial Harbor. Dredge 150,000 cubic yards from the authorized Federal channel. Existing conditions show a considerable reduction in the water depths available for the commercial users.

## 2. Customer Impact.

a. Definition. This criterion identifies the importance of accomplishing the proposed work as to its impact upon the customer utilizing one or more of the project features in the Budget Year. This may be an economic impact or it might prevent the customer from utilizing one or more of the purposes or features of the pro-

ject. This criterion is linked to where the customer comes from who is using the project feature. One component of this criterion is the probability or likelihood of adverse impact if the work is not performed. The adverse impact ranges from a high to a low level. A high level would indicate that if the work is not funded the condition and function of the component will prevent a level of service expected by the traditional customers. A medium level means you will limit, while a low level means you may limit, the level of service expected by traditional customers. The second component of this criterion relates to the severity of consequences if the work is not funded. The severity ranges from high to low. A high severity indicates that there will be significant regional (national) impacts if the work is not performed. A high severity rating would indicate that customers of the project feature come from far reaching areas of the country, even internationally, or provide services to far reaching areas of the country. A medium severity indicates there will be moderate regional impacts, while a low severity indicates local impacts, if the work is not performed. A medium severity rating would be as described earlier, but the customer is from, or provides services to, areas that are closer to the project and are more regional. A low severity rating indicates the customer is from, or provides services to, the local area around the project and only has local impacts. A severity rating of zero indicates no impact on customers.

b. Examples.

Not funding lock gate anchor bolt repairs will result in a high probability of gate failure causing a complete shutdown to navigation.

Not funding dredging of the harbor will cause vessels to light-load and require more transits to bring the same tonnage to the port.

Not funding the work package will prevent the tornado damaged toilet vault from being replaced and will necessitate closing of the campground.

Not funding the repair to the turbine will result in only 80% availability of the hydropower plant and require the PMA to find alternative power from another source.

Not funding the dredging of a recreational harbor may limit the use of the harbor and will adversely impact local users, marinas and businesses.

A section of breakwater at a large deep-draft harbor is displaying signs of failure. Not funding repairs in the BY could lead to failure of the structure and may

(**LOW**) limit vessel traffic during storms, and may redirect vessels to other harbors or cause users to divert cargoes to rail shipping at increased costs (**HIGH to MED**).

Three of five combination restroom/shower buildings at a 300 site campground are in deplorable condition according to inspection reports and customer comment cards. These facilities serve 200 campsites. They have experienced spot repairs and renovations over the past several years but are expected to be in such condition by the end of the budget year as to force facility closure. Reconstruction will cost \$550,000. The probability is high that the expected or traditional level of customer service will be prevented should these facilities be closed. Since visitors to this campground come from a several-state region, the severity of closure will be medium in nature. There will be moderate regional impact.

Purchase thrust bearing cooler at Old Hickory L&D.

Lorain Harbor Dredging Commercial Harbor. Dredge 150,000 cubic yards from the authorized Federal channel. Existing conditions show a considerable reduction in the water depths available for the commercial users. This requires the vessels to “light load” thereby increasing the operational costs to the port and harbor users.

### 3. **Safety.**

a. Definition. This criterion identifies the importance of accomplishing the proposed work in order to sustain a safe environment. This criterion applies to both personnel and property. You should note that items presenting an immediate hazard should be repaired or alternative measures taken from current year O&M funds. One component of this criterion is the probability of adverse impact if the work is not funded. The adverse impact has 5 rating levels, ranging from a high to a low level. A high level would indicate that, if the work is not funded, you would expect that an adverse impact would be likely to occur frequently to some component of the project. A medium-high level means an adverse impact will occur several times, while a medium level means an adverse impact is likely to occur sometime to some component of the project. A medium-low level means an adverse impact is unlikely but possible to occur to some component of the project, while a low level means an adverse impact is not expected to occur. The second component of this criterion relates to the severity of consequences if the work is not funded. The severity has four ratings, ranging from high to negligible. A high severity indicates that death or permanent total disability to a person or major property damage/system loss to a component of the project will occur. A medium severity indi-

cates a permanent partial disability or temporary total disability in excess of 3 months will occur to a person or significant property damage/major system damage to a component of the project. A low severity indicates that minor injury or compensable injury or illness to person or minor property/system damage to a component of the project will occur. A negligible severity rating indicates first aid or minor supportive medical treatment to a person or minor system impairment to a component of the project occurs.

b. Examples.

Not funding the repair of the hand railings to the lower lock miter gate has a rating of 1 from the RACM.

Not funding the repairs to the electrical hook-up to campsites 5-15 result in a rating of 5 from the RACM.

Not funding the dam safety study for reservoir X presents a safety risk to downstream residents because the reservoir has no emergency spillway outlet. There is a high probability that if a PMF event were to occur the reservoir may be overtopped, causing failure of the embankment. This work package has a rating of 1 from the RACM.

The last periodic inspection at hydropower plant Z found exposed electrical wiring. Not funding corrective action to this hazard could produce harm to unsuspecting personnel who might get too close to it. This work package has a rating of 3 from the RACM.

The stairs on the stairway in the interior of dam Y become slippery when wet. In the last 3 years one worker slipped on the stairs, resulting in 2 lost days of work. This work package has a rating of 3 from the RACM.

Not funding repairs to a severely deteriorated section of breakwater may result in several occurrences of significant property damage/physical injury to vessels, barges and crews within the harbor during high wave conditions.

A section of harbor jetty is displaying signs of failure. Not funding repairs in the BY could lead to failure and cause a hazard to navigation. Vessel striking is possible (**MED to LOW**) with some damage to the vessel (**LOW**).

Three of five combination restroom/shower buildings at a 300-site campground are in deplorable condition according to inspection reports and customer comment



cards. These facilities serve 200 campsites. They have experienced spot repairs and renovations over the past several years but are expected to be in such condition by the end of the budget year as to force facility closure. Reconstruction will cost \$550,000. The probability of adverse safety impacts if this work is not performed is remote or low. Some overcrowding of other facilities may occur as a result of the closure of these facilities resulting in an “unlikely but possible” safety hazard. The severity of consequences is also estimated to be low or marginal due to possible minor injuries or property damage associated with overcrowding of adjacent facilities.

Install stairway access to overhead crane cab at Laurel River Lake.

Lorain Harbor Dredging Commercial Harbor. Existing conditions show a considerable reduction in the water depths available for the commercial users. This requires the vessels to “light load” thereby increasing the likelihood that vessels will strike the channel bottom.

#### 4. **Economic Benefits.**

a. Definition. This criterion identifies the economic benefit of funding the proposed work. It utilizes net benefits, which is derived by subtracting the cost of the work package from the present value of benefits associated with the project feature that is tied to the work package. Development of benefits should not involve laborious, detailed calculations, but should be derived using a simplified methodology. It is left to the judgment of field offices to determine the appropriate effort required in developing the benefits. This criterion will help compare work packages with low costs against those with moderate to high costs by providing the economic benefit of doing the work. It will provide a tool that will allow decisions to be made, such as funding numerous less costly work packages rather than one high cost work package due to the economic cost effectiveness. Economic benefits are applicable to Federal revenue generation, reduction of future O&M, regional economic perspective, etc. One component of this criterion is the probability of benefits if the work is funded. The probability of benefits ranges from a high to a low level. A high level would indicate that, if the work is funded, you are certain that benefits will accrue over a time frame of BY + 5 and the deterioration rate of the component is increasing. A medium level means benefits are expected, while a low level means benefits are possible, to accrue over a time frame of BY + 5. The deterioration rate is steady for a medium level, while a low level warrants monitoring of the component. The second component of this criterion relates the level of benefits to the amount of net benefits or funds saved if the work is performed. The level of benefits ranges from

high to low. A high benefit indicates that net benefits or funds saved are valued at greater than \$150,000 for some component of the project. A medium benefit indicates the net benefits or funds saved are valued between \$150,000 and \$50,000, while a low benefit indicates the net benefits or funds saved are less than \$50,000, for some component of the project. A level of benefits rating of zero indicates no economic impact.

b. Examples.

Funding the hydropower generator rewind at a cost of \$500k will result in annual revenues of \$700k, providing a high economic benefits rating.

Funding campground X electrical upgrade at a cost of \$100k will provide electricity to an area that previously had none. This upgrade will allow camping fees to be increased and provide annual revenues of \$150k, providing a moderate economic benefits rating.

Funding the repair to L/D Z valve filling system at a cost of \$250,000 will allow quicker locking times. This is a high usage lock, and the proposed work will reduce the waiting times for tow traffic to lock through. It is estimated that net benefits will result in a high rating.

Harbor Y entrance channel is shoaled in and only provides 2 feet of draft. This prevents 90 percent of vessel traffic from entering or exiting the harbor. It is estimated that the economic benefit from performing maintenance dredging would produce \$100k in net benefits and a moderate rating.

Funding the dredging of a shoal from a harbor entrance channel will allow the full loading of deep draft vessels that use the harbor and will result in \$75,000 in net benefits to the shipping industry.

Repair of a 1,000-ft section of breakwater will consist of encasing a failing timber crib structure with armor stone at a cost of \$2M. Given that, in the future, the breakwater will deteriorate to the point of failure and repair costs would double (steel sheet pile vs. stone, more materials, etc.), reduction of future O&M costs within 5 years are certain to expected (**HIGH to MED**) and savings or net benefits are in the range of \$2M (**HIGH**).

Three of five combination restroom/shower buildings at a 300-site campground are in deplorable condition according to inspection reports and customer comment cards. These facilities serve 200 campsites. They have experienced spot repairs and

renovations over the past several years but are expected to be in such condition by the end of the budget year as to force facility closure. Reconstruction will cost \$550,000. It is certain (high probability) that economic benefits will accrue from the performance of this work. These benefits will be in the categories of Federal income generation, reduced future O&M, and regional economic perspective. Net benefits will be high (in excess of \$150,000). Lost user fees alone are expected to be \$75,000 annually. O&M costs saved over the next 5 years are estimated to be \$75,000. As many local tourist-related businesses are dependent upon the recreational use of this project, lost local revenues are estimated at \$500,000 per year.

P&S for rehabilitation of generating equipment at Barkley Dam Power Plant.

Lorain Harbor Dredging Commercial Harbor. Existing conditions show a considerable reduction in the water depths available for the commercial users. This requires the vessels to “light load” thereby increasing the operational costs to the port and harbor users.

## **5. Non-Corps Compliance Issues.**

a. Definition. This criterion identifies whether, or to what degree, the proposed work is needed due to noncompliance of some non-Corps regulation or law. One component of this criterion is the probability of adverse impact if the work is not funded. The adverse impact ranges from a high to a low level. A high level would indicate that if the work is not funded you are certain that official notification of noncompliance will be received before the end of the Budget Year. A medium level means you expect, while a low level means it is possible, that official notification of noncompliance will be received by the end of the Budget Year. The second component of this criterion relates to the severity of consequences if the work is not funded. The severity ranges from high to low. A high severity indicates that non-compliance with Federal/State laws or regulations may result in fines or other legal action. A medium severity indicates you are receiving agency/public/industry pressure, while a low severity indicates minimal interest or pressure, to correct a deficiency to some component of the project. A severity rating of zero indicates there are no noncompliance issues.

b. Examples.

A recent inspection at L/D M revealed a leaking diesel fuel tank. Not funding this work package results in noncompliance with applicable regulatory requirements.

The sewage treatment plant at reservoir E campground is old and past its design life. Not funding this work package to replace the treatment plant may result in the current plant not being able to meet water quality requirements for its discharge effluent, which would produce a noncompliance with regulatory requirements.

Not funding repairs to a confined disposal facility (CDF) dike may result in the seepage of contaminated material into the surrounding environment causing a violation of the facility's EIS and potential legal action.

A section of breakwater requires repair. The structure is on the National Historic Register. It is unlikely that there will be a complaint by SHPO even if the structure fails (**LOW**). The final repairs, regardless of when work is performed, will look the same (**N/A**).

Three of five combination restroom/shower buildings at a 300-site campground are in deplorable condition according to inspection reports and customer comment cards. These facilities serve 200 campsites. They have experienced spot repairs and renovations over the past several years but are expected to be in such condition by the end of the budget year as to force facility closure. Reconstruction will cost \$550,000. The probability is certain or high that notifications of noncompliance will be received from state and local sewage and sanitary enforcement officials should this work not be accomplished. The severity is judged to be medium since closure of the facility will negate any legal or court action. However, significant public and industry pressure will be experienced.

Repair shaft coupling leak unit #1 at Cordell Hull Dam and Reservoir.

### Reduction of Future O&M Costs Worksheet

#### Part 1.

What is the cost of the work package? \_\_\_\_\_ (a)

How much O&M dollars are spent annually on this in its current condition? \_\_\_\_\_  
(b)

How much O&M dollars would be spent on this annually if the work packages was performed? \_\_\_\_\_ (c)

Savings realized in 5 years (d) = (b-c) x 5

Compare (d) to (a):

If (a) < (d), then HIGH

If (a) = (d), then MEDIUM

If (a) > (d), then LOW

#### Part 2.

If Preventative Maintenance activity is not performed, at what point will the nature of the work item change to replacement of structural members/facilities/equipment?

1 year	2-3 years	3-5 years
HIGH	MEDIUM	LOW

Since this is an “and/or” situation, use the higher rating of the two parts for the matrix value.

## SWD FY 03 O&M Budget Prioritization Criteria

### Definitions and Examples

#### 5. Public Relations.

a. Definition. This criterion identifies whether, or to what degree, the proposed work has customer interest. A high rating results when the level of interest is from a **national** perspective (from the President, Senators or Congressmen/women). A medium rating results when the level of interest is from the **state** perspective (from the Governor, State Senators or State Representatives). A low rating results when the level of interest is from the **local** perspective (from Bass Clubs, Marina Operator Associations, County Judges or other County Officials, Mayors, Conservation organizations, local groups or individuals).

b. Examples. High – 100: The work identified by the work package has been the subject of several congressionals and/or a congressional staffer has contacted the Operations Manager and/or the Chief of Operations concerning the work.

Medium – 50: The work identified by the work package has been the subject of several meetings with the Governor and/or a State Representative has talked with the Chief of Operations about the work.

Low – 25: The work identified by the work package has been the subject of numerous phone calls with local Bass Clubs or local groups and several meeting with the county judge.

#### 6. Non-Corps Compliance Issues.

a. Definition. This criterion identifies whether, or to what degree, the proposed work is needed due to noncompliance of some non-Corps regulation or law. A high rating results when an EIS, EA or inspection report identifies the subject work to be performed as needed due to noncompliance with regulations or law and the project **will be subject to legal action** and/or fines. A medium rating results when an EIS, EA or inspection report identifies the subject work to be performed as needed due to noncompliance with regulations or law, but the **project will not be subject to legal action** and/or fines. A low rating would result when an EIS, EA or inspection report identifies compliance with regulations or law, but the **potential exists for noncompliance** in the BY+1 or beyond.

b. Examples. High Rating – 100: The work identified by the work package will correct problems with the water system in Happy Park. The project has received a letter from the state environmental department stating that the water system in Happy Park is not in compliance with state requirements and if not corrected the state will take legal action and impose fines. The project has implemented temporary measures and submitted a plan for correcting the problem. The state has given the project until BY+1 to implement a permanent solution.

Medium Rating – 50: The work identified by the work package will restore a dredge disposal area in compliance with a permit from the U.S. Fish and Wildlife Service. The project has a permit from the U.S. Fish and Wildlife Service to dispose of dredge material in an area on a wildlife refuge. A condition of the permit is that an abandon disposal area will be restored in the BY+1. If the restoration is not performed the permit will be revoked.

Low Rating – 25: The work identified by the work package will correct a drainage problem at the project's marine terminal. An ERGO inspection identified a potential violation of state regulations in the BY+1 if the subject work is not performed.

## 7. **Safety.**

a. Definition. This criterion identifies the importance of accomplishing the proposed work in order to maintain a safe project environment applicable to personnel and property. Proposed work items that address a current hazard should be repaired immediately or alternative measures taken using available O&M funds. This criterion can be a documented safety problem resulting from an annual or periodic inspection report, dam safety assurance studies, engineering judgment, scheduled maintenance needs or viable concerns expressed by using interests, public or governmental entities and/or resource groups.

b. Examples. Not funding the riprap grouting at the recreation area adjacent to the stilling basin at JR reservoir has a rating of 40 with medium probability of adverse impacts and a low severity of consequence.

The spillway at reservoir X experienced erosion during the last significant rainfall presenting a safety risk to the urbanized areas located downstream. Preliminary investigations indicated the need for a dam safety study to evaluate the need to extend the spillway structure. The work package has a rating of 80 with medium

probability of adverse impact and high severity of consequences for a high hazard dam; a low hazard dam will yield a rating of 60 with medium probability of adverse impact and medium severity of consequence.

The road located on the dam crest, which also serves as a project access as well as locally used roadway has developed potholes and longitudinal cracking due to foundation problems and rainwater seepage. The investigating officer attributed one minor traffic accident involving one vehicle to the dangerous condition of the roadway. Maintenance for the road is a government responsibility. This work package has a rating of 40 with low probability of adverse impact and medium severity of consequence.

The last periodic inspection at Lock and Dam X found excessive leakage into the lower inspection gallery. While sump pumps dewater the gallery, the amount of flow will eventually cause the leakage to inundate the electric lighting causing a deadly hazard to the structure operators. This work package rates a score of 80 with a medium probability of impact and high severity of consequences.

Mowing and vegetation control efforts at recreation areas of Lock and Dam X need to be increased due to the documented incidents of snakebites and alligator attacks on the public and rangers. This work package has a rating of 80 with a medium-high probability of adverse impact and medium severity of consequence.

The elevator at the outlet works structure of Dam X has broken down, become unusable and is in need of repair. While access to the dry well is available through the stairwell, it is very difficult to carry heavy tools and replacement parts through a six-story climb presenting a safety hazard to the project operators. This work package has a rating of 20 with a low probability of adverse impact and low severity of consequence.



## Revised Criteria Definitions

8 December 2000

# DRAFT

## LRD FY 02 O&M Budget Prioritization Criteria

### Revised Definitions and Examples

#### 1. **Mission Accomplishment.**

a. Definition. This criterion identifies the importance of accomplishing the proposed work in order for the project to perform its purpose in the Budget Year. Most projects have numerous authorized purposes. For example, a reservoir has project purposes such as flood control, recreation (camping facilities and visitor centers), and possibly hydropower. A navigation lock site has project purposes of the lock passing vessels through it and of the dam to help control pool levels, both upstream and downstream. One component of this criterion is the probability or likelihood of adverse impact to the mission if the work is not funded. The adverse impact to the mission ranges from a high to a low level. A high level would indicate that, if the work is not funded, you would expect to lose the ability to perform some portion of the project purpose. A medium level means you could lose, while a low level means you would not expect to lose, the ability to perform some portion of the project purpose. The second component of this criterion relates to the severity of consequences if the work is not funded. The severity ranges from high to low. A high severity indicates that catastrophic loss or significant damage to some component of the project would severely or totally restrict project operations. A medium severity indicates a critical loss or moderate damage, while a low severity indicates a marginal loss or minimal damage, to some component of the project, which would moderately or minimally, respectively, restrict project operations. A severity rating of zero indicates no impact on mission accomplishment.

#### b. Examples.

##### OLD EXAMPLES:

Not funding repairs to a miter gate will cause a high probability that the gate will fail and become inoperable.

Not funding repairs to a breakwater pier will result in failure of a portion of the structure and cause stone to fall partway into the navigation channel, restricting traffic to one-way.

Not funding renovation to camp pads will have moderate impacts to campers due to the deteriorated condition of the pads.

Not funding the non-baseline maintenance replacement of a certain component of a generator will have no impacts to the plant operation, but will increase replacement costs if delayed.

Not funding road paving will create a loss of campground visitors and subsequent loss of revenue.

#### NEW EXAMPLES:

Not funding repairs to a storm damaged rubble mound breakwater will result in the failure of a portion of the structure and will severely restrict the use of the harbor by commercial shipping interests.

A section of harbor jetty, confirmed by an underwater investigation, is displaying signs substructure failure. Not funding and initiating repairs in the BY could **(LOW)** result in failure of a portion of the structure and partially block the channel causing restrictions to vessels **(MEDIUM)**.

Three of five combination restroom/shower buildings at a 300-site campground are in deplorable condition according to inspection reports and customer comment cards. These facilities serve 200 campsites. They have experienced spot repairs and renovations over the past several years but are expected to be in such condition by the end of the budget year as to force facility closure. Reconstruction will cost \$550,000. The probability that these facilities will be closed and lose their ability to perform the recreation mission at this project is high. The severity of operational restrictions due to the closure of these facilities will be moderate. While a small portion of the campground may remain open, project visitation will be severely impacted.

Div rank 2032600 161KV transformer cooling system at Barkley Dam and Barkley Lake.

Lorain Harbor Dredging Commercial Harbor. Dredge 150,000 cubic yards from the authorized Federal channel. Existing conditions show a considerable reduction in the water depths available for the commercial users.

## **2. Customer Impact.**

a. Definition. This criterion identifies the importance of accomplishing the proposed work as to its impact upon the customer utilizing one or more of the project features in the Budget Year. This may be an economic impact or it might prevent the customer from utilizing one or more of the purposes or features of the project. This criterion is linked to where the customer comes from who is using the project feature. One component of this criterion is the probability or likelihood of adverse impact if the work is not performed. The adverse impact ranges from a high to a low level. A high level would indicate that if the work is not funded the condition and function of the component will prevent a level of service expected by the traditional customers. A medium level means you will limit, while a low level means you may limit, the level of service expected by traditional customers. The second component of this criterion relates to the severity of consequences if the work is not funded. The severity ranges from high to low. A high severity indicates that there will be significant regional (national) impacts if the work is not performed. A high severity rating would indicate that customers of the project feature come from far reaching areas of the country, even internationally, or provide services to far reaching areas of the country. A medium severity indicates there will be moderate regional impacts, while a low severity indicates local impacts, if the work is not performed. A medium severity rating would be as described earlier, but the customer is from, or provides services to, areas that are closer to the project and are more regional. A low severity rating indicates the customer is from, or provides services to, the local area around the project and only has local impacts. A severity rating of zero indicates no impact on customers.

c. Examples.

### **OLD EXAMPLES:**

Not funding lock gate anchor bolt repairs will result in a high probability of gate failure causing a complete shutdown to navigation.

Not funding dredging of the harbor will cause vessels to light-load and require more transits to bring the same tonnage to the port.

Not funding the work package will prevent the tornado-damaged toilet vault from being replaced and will necessitate closing of the campground.

Not funding the repair to the turbine will result in only 80% availability of the hydropower plant and require the PMA to find alternative power from another source.

#### NEW EXAMPLES:

Not funding the dredging of a recreational harbor may limit the use of harbor and will adversely impact local users, marinas, and businesses.

A section of breakwater at a large deep-draft harbor is displaying signs of failure. Not funding repairs in the BY could lead to failure of the structure and may **(LOW)** limit vessel traffic during storms, and may redirect vessels to other harbors or cause users to divert cargoes to rail shipping at increased costs **(HIGH to MED)**.

Three of five combination restroom/shower buildings at a 300-site campground are in deplorable condition according to inspection reports and customer comment cards. These facilities serve 200 campsites. They have experienced spot repairs and renovations over the past several years but are expected to be in such condition by the end of the budget year as to force facility closure. Reconstruction will cost \$550,000. The probability is high that the expected or traditional level of customer service will be prevented should these facilities be closed. Since visitors to this campground come from a several-state region, the severity of closure will be medium in nature. There will be moderate regional impact.

Div Rank 2032850 Purchase thrust bearing cooler at Old Hickory L&D.

Lorain Harbor Dredging Commercial Harbor. Dredge 150,000 cubic yards from the authorized Federal channel. Existing conditions show a considerable reduction in the water depths available for the commercial users. This requires the vessels to “light load” thereby increasing the operational costs to the port and harbor users.

### 3. **Safety.**

a. Definition. This criterion identifies the importance of accomplishing the proposed work in order to sustain a safe environment. This criterion applies to both personnel and property. You should note that items presenting an immediate hazard should be repaired or alternative measures taken from current year O&M

funds. One component of this criterion is the probability of adverse impact if the work is not funded. The adverse impact has five rating levels, ranging from a high to a low level. A high level would indicate that if the work is not funded you would expect that an adverse impact would be likely to occur frequently to some component of the project. A medium-high level means an adverse impact will occur several times, while a medium level means an adverse impact is likely to occur sometime to some component of the project. A medium-low level means an adverse impact is unlikely but possible to occur to some component of the project, while a low level means an adverse impact is not expected to occur. The second component of this criterion relates to the severity of consequences if the work is not funded. The severity has four ratings, ranging from high to negligible. A high severity indicates that death or permanent total disability to a person or major property damage/system loss to a component of the project will occur. A medium severity indicates a permanent partial disability or temporary total disability in excess of 3 months will occur to a person or significant property damage/major system damage to a component of the project. A low severity indicates that minor injury or compensable injury or illness to person or minor property/system damage to a component of the project will occur. A negligible severity rating indicates first aid or minor supportive medical treatment to a person or minor system impairment to a component of the project occurs.

b. Examples.

OLD EXAMPLES:

Not funding the repair of the hand railings to the lower lock miter gate has a rating of 1 from the RACM.

Not funding the repairs to the electrical hook-up to campsites 5-15 result in a rating of 5 from the RACM.

Not funding the dam safety study for reservoir X presents a safety risk to downstream residents because the reservoir has no emergency spillway outlet. There is a high probability that if a PMF event were to occur the reservoir may be overtopped, causing failure of the embankment. This work package has a rating of 1 from the RACM.

The last periodic inspection at hydropower plant Z found exposed electrical wiring. Not funding corrective action to this hazard could produce harm to unsus-

pecting personnel who might get too close to it. This work package has a rating of 3 from the RACM.

The stairs on the stairway in the interior of dam Y become slippery when wet. In the last three years one worker slipped on the stairs, resulting in 2 lost days of work. This work package has a rating of 3 from the RACM.

#### NEW EXAMPLES:

Not funding repairs to a severely deteriorated section of breakwater may result in several occurrences of significant property damage/physical injury to vessels, barges and crews within the harbor during high wave conditions.

A section of harbor jetty is displaying signs of failure. Not funding repairs in the BY could lead to failure and cause a hazard to navigation. Vessel striking is possible (**MED to LOW**) with some damage to the vessel (**LOW**).

Three of five combination restroom/shower buildings at a 300-site campground are in deplorable condition according to inspection reports and customer comment cards. These facilities serve 200 campsites. They have experienced spot repairs and renovations over the past several years but are expected to be in such condition by the end of the budget year as to force facility closure. Reconstruction will cost \$550,000. The probability of adverse safety impacts if this work is not performed is remote or low. Some overcrowding of other facilities may occur as a result of the closure of these facilities resulting in an “unlikely but possible” safety hazard. The severity of consequences is also estimated to be low or marginal due to possible minor injuries or property damage associated with overcrowding of adjacent facilities.

Div rank 2052200 Install stairway access to overhead crane cab at Laurel River Lake.

Lorain Harbor Dredging Commercial Harbor. Existing conditions show a considerable reduction in the water depths available for the commercial users. This requires the vessels to “light load” thereby increasing the likelihood that vessels will strike the channel bottom.

#### 4. Economic Benefits.

a. Definition. This criterion identifies the economic benefit of funding the proposed work. It utilizes net benefits, which is derived by subtracting the cost of the

work package from the present value of benefits associated with the project feature that is tied to the work package. Development of benefits should not involve laborious, detailed calculations, but should be derived using a simplified methodology. It is left to the judgment of field offices to determine the appropriate effort required in developing the benefits. This criterion will help compare work packages with low costs against those with moderate to high costs by providing the economic benefit of doing the work. It will provide a tool which will allow decisions to be made, such as funding numerous less costly work packages rather than one high cost work package due to the economic cost effectiveness. Economic benefits are applicable to Federal revenue generation, reduction of future O&M, regional economic perspective, etc. One component of this criterion is the probability of benefits if the work is funded. The probability of benefits ranges from a high to a low level. A high level would indicate that if the work is funded you are certain that benefits will accrue over a time frame of BY + 5 and the deterioration rate of the component is increasing. A medium level means benefits are expected, while a low level means benefits are possible, to accrue over a time frame of BY + 5. The deterioration rate is steady for a medium level, while a low level warrants monitoring of the component. The second component of this criterion relates the level of benefits to the amount of net benefits or funds saved if the work is performed. The level of benefits ranges from high to low. A high benefit indicates that net benefits or funds saved is valued at greater than \$150,000 for some component of the project. A medium benefit indicates the net benefits or funds saved is valued between \$150,000 and \$50,000, while a low benefit indicates the net benefits or funds saved are less than \$50,000, for some component of the project. A level of benefits rating of zero indicates no economic impact.

b. Examples.

OLD EXAMPLES:

Funding the hydropower generator rewind at a cost of \$500k will result in annual revenues of \$700k, providing a high economic benefits rating.

Funding campground X electrical upgrade at a cost of \$100k will provide electricity to an area which previously had none. This upgrade will allow camping fees to be increased and provide annual revenues of \$150k, providing a moderate economic benefits rating.

Funding the repair to L/D Z valve filling system at a cost of \$250,000 will allow quicker locking times. This is a high usage lock and the proposed work will reduce the waiting times for tow traffic to lock through. It is estimated that net benefits will result in a high rating.

Harbor Y entrance channel is shoaled in and only provides 2 feet of draft. This prevents 90 percent of vessel traffic from entering or exiting the harbor. It is estimated that the economic benefit from performing maintenance dredging would produce \$100k in net benefits and a moderate rating.

#### NEW EXAMPLES:

Funding the dredging of a shoal from a harbor entrance channel will allow the full loading of deep draft vessels that use the harbor and will result in \$75,000 in net benefits to the shipping industry.

Repair of a 1,000-ft section of breakwater will consist of encasing a failing timber crib structure with armor stone at a cost of \$2M. Given that in the future, the breakwater will deteriorate to the point of failure and repair costs would double (steel sheet pile vs. stone, more materials, etc.), reduction of future O&M costs within 5 years are certain to expected (**HIGH to MED**) and savings or net benefits are in the range of \$2M (**HIGH**).

Three of five combination restroom/shower buildings at a 300-site campground are in deplorable condition according to inspection reports and customer comment cards. These facilities serve 200 campsites. They have experienced spot repairs and renovations over the past several years but are expected to be in such condition by the end of the budget year as to force facility closure. Reconstruction will cost \$550,000. It is certain (high probability) that economic benefits will accrue from the performance of this work. These benefits will be in the categories of Federal income generation, reduced future O&M, and regional economic perspective. Net benefits will be high (in excess of \$150,000). Lost user fees alone are expected to be \$75,000 annually. O&M costs saved over the next 5 years are estimated to be \$75,000. As many local tourist related businesses are dependent upon the recreational use of this project, lost local revenues are estimated at \$500,000 per year.

Div rank 2019213 P&S for rehabilitation of generating equipment at Barkley Dam Power Plant.

Lorain Harbor Dredging Commercial Harbor. Existing conditions show a considerable reduction in the water depths available for the commercial users. This



requires the vessels to “light load” thereby increasing the operational costs to the port and harbor users.

## 5. Non-Corps Compliance Issues.

a. Definition. This criterion identifies whether, or to what degree, the proposed work is needed due to noncompliance of some non-Corps regulation or law. One component of this criterion is the probability of adverse impact if the work is not funded. The adverse impact ranges from a high to a low level. A high level would indicate that if the work is not funded, you are certain that official notification of noncompliance will be received before the end of the Budget Year. A medium level means you expect, while a low level means it is possible, that official notification of noncompliance will be received by the end of the Budget Year. The second component of this criterion relates to the severity of consequences if the work is not funded. The severity ranges from high to low. A high severity indicates that noncompliance with Federal/state laws or regulations may result in fines or other legal action. A medium severity indicates you are receiving agency/public/industry pressure, while a low severity indicates minimal interest or pressure, to correct a deficiency to some component of the project. A severity rating of zero indicates there are no noncompliance issues.

b. Examples.

### OLD EXAMPLES:

A recent inspection at L/D M revealed a leaking diesel fuel tank. Not funding this work package results in noncompliance with applicable regulatory requirements.

The sewage treatment plant at reservoir E campground is old and past its design life. Not funding this work package to replace the treatment plant may result in the current plant not being able to meet water quality requirements for its discharge effluent, which would produce a noncompliance with regulatory requirements.

### NEW EXAMPLES:

Not funding repairs to a confined disposal facility (CDF) dike may result in the seepage of contaminated material into the surrounding environment causing a violation of the facility's EIS and potential legal action.

A section of breakwater requires repair. The structure is on the National Historic Register. It is *unlikely* that there will be a complaint by SHPO even if the structure fails (**LOW**). The final repairs, regardless of when work is performed, will look the same (**N/A**).

Three of five combination restroom/shower buildings at a 300-site campground are in deplorable condition according to inspection reports and customer comment cards. These facilities serve 200 campsites. They have experienced spot repairs and renovations over the past several years but are expected to be in such condition by the end of the budget year as to force facility closure. Reconstruction will cost \$550,000. The probability is certain or high that notifications of noncompliance will be received from state and local sewage and sanitary enforcement officials should this work not be accomplished. The severity is judged to be medium since closure of the facility will negate any legal or court action. However, significant public and industry pressure will be experienced.

Div rank 2039650 Repair shaft coupling leak unit #1 at Cordell Hull Dam and Reservoir.

## **LRD Bucket Process**

17 January 2001

**BUCKET DEFINITIONS,**

**TARGET RANGES, ABS RANKING**

**AND PRIORITIZATION PROCESS**

### **BUCKET DEFINITIONS AND TARGET / RANKING RANGES**

Level 1 - Baseline. Contains operations and maintenance work packages qualifying as items performed annually. Districts must stay within the FY 02 cap. ABS district rank range is from 1 - 19999 (division rank range from 1 - 1999999).

Level 2 - Operations. Division will establish a maximum amount of allowable funded operations work, which will be based on the FY 02 cap. Not all of a district's operations cap is contained solely within Level 1. Any additional funded operations work packages in level 2 will be placed within an ABS district rank range from 20000 - 21500 (division rank range from 2000000 - 2150000). Any operations work packages exceeding the district cap will be placed within an ABS district rank range from 29000 - 29999 (division rank range from 2900000 - 2999999).

#### Level 2 - Maintenance.

Bucket A: Districts place their highest priority maintenance work into this bucket. They are limited to a maximum dollar value equal to 75% of their FY 02 Level 2 funded maintenance amount (see separate table listing to determine dollar value). ABS district rank range is from 22000 - 24500 (division rank range from 2200000 - 2450000).

Maintenance work using the Mission Critical criterion within Bucket A would be needed so that the system / component would not lose its ability to perform a portion of the project purpose or to prevent loss or significant damage to the system, equipment, facilities, item, public property, navigation reach, etc. Or the work may be needed because the condition and function of the project or a component will have an adverse impact by preventing a level of service expected by traditional customers if not funded. If the work is safety related, not funding it will have an adverse impact which will likely occur frequently to the system, item, facility, etc, resulting in permanent disability, system loss or major property damage. If the work involves a compliance issue, not funding it would most certainly result in official notification or knowledge of noncompliance and may result in fines or other legal action.

Examples include, but are not limited to: Fleet/plant hired or contract labor; E&D for critical maintenance; justified level of service recreation maintenance (i.e., work that is basically baseline, but which does not qualify as such); other work that is a 'must do' and should really be baseline, but it doesn't meet the definition; dam/power plant scheduled maintenance; continuing contracts which were part of the President's Budget in PY-1; work if not performed would result in severe impacts to project performance jeopardizing mission accomplishment.

Bucket B: Districts place their next highest priority maintenance work into this bucket. The dollar limit for these work packages falls within a range of 75 through 115 percent of their FY02 Level 2 funded maintenance amount (see separate table

listing to determine dollar value). ABS district rank range is from 25000 - 26500 (division rank range from 2500000 - 2650000).

Examples include, but are not limited to: Other remaining in-house labor not included in Bucket A; work which if not funded would have major impacts to project performance and mission accomplishment; maintenance necessary to meet performance goals but the project itself is not as important as others in Bucket A because it does not affect as many users; replacement of mission critical equipment which performs well but is being replaced because of age / parts availability; work which if not performed would lead to partial failures or conditions which lead to a partial failure; dredging at recreation / shallow draft channels and harbors, especially those that have political interest.

Bucket C: Districts place all of their remaining Level 2 maintenance work packages beyond the 115% dollar limit into this bucket. ABS district rank range is from 27000 - 28500 (division rank range from 2700000 - 2850000).

Examples: Dredging at recreational / shallow draft channels and harbors; non-critical, nonsafety-related items; items that can be deferred to the next year; items that are desirable but can be allowed to slip into the next year; work which if not performed would have minor impacts to project performance and mission accomplishment; maintenance work necessary to meet performance goals but no real constituency affected by project; procurement of vehicles, floating plant, and mobile equipment that, although justified economically, could be replaced by rentals or contract services.

Levels 3 and 4 - No change from past guidance.

### PROCESS TO PRIORITIZE WORK PACKAGES

1. Assumption is that, prior to prioritizing Level 2 maintenance, we have validated the baseline (or come up with an interim process for FY 03).
2. Districts submit all FY 03 work packages and have placed them into appropriate funding levels using ABS. They will place Level 2 maintenance work packages in either Bucket A, B, or C using an appropriate ABS district rank and previously defined definitions for the buckets.
3. Each district (Operation Managers) develops five ratings (and scores) for all Level 2 maintenance packages within the bucket where the Division target cut-off

funding falls within using prioritization criteria, rating matrices, and predetermined weights. Based on the current definitions, this is Bucket B.

4. District/MSD team (working group or Chiefs of Operations) reviews placement of Level 2 maintenance work packages in Bucket A for consistency. If a work package is found not to be consistent and is rejected, the package is placed into the top of Bucket B and the district forfeits that amount of funding for Bucket A (funds are placed into Bucket B and are available to any district). MSD has the final word in any discrepancy.

5. District/MSD team (working group or Chiefs of Operations) reviews and discusses work package ratings for the bucket where the Division target falls within (currently defined as Bucket B). The team decides on a draft priority of all work packages in the bucket. Use work package scores as a tool to compliment district professional judgment.

6. Chiefs of Operations / DPMs meet to discuss draft priority of work packages falling within the bucket where the Division target falls within (currently defined as Bucket B), make adjustments, and finalize work package priority through target level. Prioritize highest priority work packages that fall outside the division target level.

## Appendix J: CERL / IWR Alternative Prioritization Criteria

### 1 - Environmental

- Legal requirement.
- Legal requirement if funding allows (reality but maybe not good to state explicitly)
- Policy
- Environmental value
  - Economic and societal benefits support expenditure
  - Nice to have if budget was unlimited

### 2 - Public Relations

- Customer surveys, complaint calls
- Local political pressures
- Congressional pressures

### 3 - Legal

- Legal requirement. Overlaps with **Environmental**.
- Legal requirement if funding allows (reality but maybe not good to state explicitly)
- Unsafe business practices that creates legal or ethical liability (applied to employees, customers, or others). Overlaps with **Social** and **Technical**.

#### 4 - Social

- Sufficient service to local area (minimum acceptable, appropriate to demand)
- Safety of customer
- Safety of employees
- Safety of others (downstream residents)

#### 5 - Economic

- Importance of project site or affected business area mission
- Importance of work package to the project site or affected business area mission
- Reduction of future O&M costs

#### 6 - Financial

- Impact on meeting financial requirements (loans, contract requirements, agreements, etc.)
- Provide minimum acceptable service (must produce power, lock tows, hold reservoir pool, etc.) Overlaps with **Social**.

#### 7 - Technical

- Condition assessment
- Structural adequacy (safety?). Overlaps with **Social** and **Legal**.
- Reduction of future O&M costs. Overlaps with **Economic**.

## Appendix K: SAD Work Package Guidance Letter and Prioritization Criteria

S: 16 March 2001

CESAD-CM-O/CESAD-CM-C (11-2-240q) 2 February 2001

MEMORANDUM FOR

COMMANDER, CHARLESTON DISTRICT  
COMMANDER, JACKSONVILLE DISTRICT  
COMMANDER, MOBILE DISTRICT  
COMMANDER, SAVANNAH DISTRICT  
COMMANDER, WILMINGTON DISTRICT

SUBJECT: Fiscal Year 2003 Operations and Maintenance, General (O&M) Budget Development and Prioritization

1. Over the past 6 months, we have been working to develop regional criteria to better prioritize O&M work across the South Atlantic Division. In addition, we revised our budget review process to enhance opportunities for input from regional business teams and management teams. The purpose of this memo is to lay out the regional criteria and process for developing and prioritizing the FY 03 O&M program throughout SAD, as approved by the Regional Management Board. This memorandum is intended as a supplement to the Budget EC and is not intended to circumvent it in any way. Our goal is to do a better job of regionally prioritizing items of work within each funding level as prescribed in the Budget EC.

2. **Regional Criteria** – The criteria approved for use in SAD for each business area are as follows: Navigation (Encl 1), Hydropower (Encl 2), Environmental Stewardship (Encl 3), and Flood Damage Reduction (Encl 4). The South Atlantic Division Regional Management Board (RMB) agreed to defer the approval of Recreation criteria until the FY 04 budget year, and to focus our current efforts on conducting recreation area self-assessments of existing recreation facilities and current



levels of service. The results of these assessments will be considered during the regional reviews of the FY 03 recreation budget. Separate guidance will be provided on these assessments. Districts should give careful attention to ensure that the criteria identified for each business area are clearly reflected in work package descriptions and justifications.

3. **Targets** – The spreadsheet, Budget Comparison FY 99-02.xls (Encl 5), gives a 4-year budgeting history broken down by business area by district that should be used as a guide in preparation of your FY 03 budget. At this time, we expect SAD's FY 03 target amount to be very close to the \$316 million we received in FY 02. Each district should plan on their target funding level remaining close to what is shown in this enclosure for FY 02.

4. **Regional Budget Review Process** – The regional process approved for use during the FY 03 budget year is shown at Encl 6, along with a narrative explanation at Encl 7. This regional process will require active participation from each district as well as HQSAD. Following are key budget review meetings:

a. The business teams listed below will meet during 7-10 May 01 for the purpose of reviewing and making recommendations on regional O&M budget priorities within each business area. These teams will validate baselines against the regional criteria, ensure that baseline packages meet the requirements of the Budget EC, and ensure that districts are consistent in their preparation of baseline work packages. The teams will not have the authority to make actual changes to a district or division work package or rank. They will be tasked with providing a report listing specific work packages recommended for changes, along with a summary of how the proposed changes would affect each district if implemented. Business teams will use the amounts for their business areas shown under the FY 02 column of Enclosure 5 as the basis for determining how changes may affect each district. Each district listed below must assign a subject matter expert to each business team. In addition, a district level O&M budget manager has been assigned to support each team.

Navigation – SAC, SAJ, SAM, SAS, & SAW + Brad Flott (SAM/budget advisor)

Hydropower – SAC, SAM, SAS, SAW + Betty Addington (SAS/budget advisor)

Environmental Stewardship – SAC, SAJ, SAM, SAS, SAW + John Hemphill

(SAM/budget advisor)

Flood Damage Reduction – SAC, SAJ, SAM, SAS, SAW + Joanne Harvey

(SAJ/budget advisor)

Recreation – SAJ, SAM, SAS, SAW + Marjorie George (SAW/budget advisor)

b. The management team will consist of the district and HQSAD Chiefs, Operations Division and the O&M Budget Managers. This team will meet during 14-16 May 01 for the purpose of reviewing recommendations from the business teams and reaching consensus on regional budget priorities across the total O&M program within SAD. The team will evaluate the overall affect the recommended changes will have on each district and business area. The management team will not make actual changes to a district or division work package or rank. They will provide a summary report to include: a list of specific work packages recommended for changes, a summary of how these changes would affect each district and business area, and a list of issues that the team could not reach consensus on and that should be considered by the RMB. This report will be provided to districts for their review in preparation for the RMB meeting.

c. The Regional Management Board will meet on 30 May 2001 to review recommendations from the management team and to develop a final prioritized MSC budget for approval by the South Atlantic Division Board of Directors (BOD) prior to submittal to HQUSACE.

5. Our overall goal is to develop a regional budget strategy that will ensure the highest priority O&M work is funded within the South Atlantic Division. It may be difficult to postpone a maintenance requirement in favor of meeting federal curation standards or updating water control plans or systems. However, our responsibility as the stewards of entire systems and resources supported through the O&M program requires that we carefully consider all requirements in the funding prioritization process. I challenge each of you to more closely consider all requirements in the initial development of your district budget.

6. Please confirm the availability of the district budget managers as proposed in paragraph 4.a. and provide the names of your district subject matter experts for each business team to John DeVeaux by 16 March 2001. Questions on the FY 03 O&M budget process may be directed to John DeVeaux, 404-562-5207 or to Susan Whittington, 404-562-5133.

FOR THE COMMANDER:

/S/

7 Encls

ANTHONY F. LEKETA

Director of Civil Works and Management

C O O R D I N A T I O N

Whittington/CM-O

DeVeaux/CM-C

Osborne/CM-C

Crews/MT

Leketa/CW

MFR:

Self-explanatory

## SAD Navigation Criteria

### *Evaluation Criteria*

#### Navigation Work Package Point

##### *System Evaluations*

1. The Navigation Work Package will be separated into four categories this year. The four categories are Deep Draft Harbors, Shallow Draft Harbors, Inland Waterways, and Other. Inland Waterways and Other will be evaluated the same way that it was evaluated last year; i.e. funding argument. Deep Draft Harbors and Shallow Draft Harbors will be evaluated on arguments and a point system.
2. A description of the categories is listed below:
  - a. Deep Draft Harbors shall include all harbors with a Navigation Depth greater than 14 feet.
  - b. Shallow Draft Harbors shall include all harbors serving the coast with a Navigation depth of 14 feet or less.
  - c. Inland Waterways shall include all inland waterways including the intercoastal waterways and turning basins/harbors designed for it.
  - d. Other shall include Removal of Aquatic Growth and Cooper River.
3. Each work package for a deep draft project or shallow draft project shall contain the funding arguments similar to the arguments used in the past. Additionally, each funding package will contain points determined by criteria listed herein for Mission Critical, Subsistence Harbor, and/or National Defense.
4. Mission Critical Points:
  - a. Thirty points will be awarded to the mission critical category for each work package that meets any of the following criteria:
    - If the maintenance dredging activity is not accomplished during the Budget Year (BY), the channel will be subject to closure by the U.S. Coast Guard in the BY. Includes all costs normally associated with funding package including planning, real estate activities, E&D, S&A, etc.

- Operational Costs and Maintenance Costs essential to prevent channel closure during BY or BY+1
- Project Condition Surveys.

b. Twenty points will be awarded to the mission critical category for each work package that meets any of the following criteria:

- If the maintenance dredging activity is not accomplished during the BY, the channel will have depth restrictions affecting 5% of the using traffic or 2 foot reduction of maintained depth whichever is more restrictive in the BY. Includes all costs normally associated with work package including planning, real estate activities, E&D, S&A, etc.
- Operational Costs and Maintenance Costs essential to prevent channel restrictions affecting 5% of the using traffic or 2 foot reduction of maintained depth during BY or BY+1.

c. Ten points will be awarded to each package that meets the following criteria:

- If the maintenance dredging activity is not accomplished during the BY, width will be restricted, such as, only 2 adjacent quarters will be available to using traffic or one-way traffic in the BY.
- Other Costs: Operational Costs and Maintenance Costs essential to prevent channel restrictions identified within this criterion during BY or BY+1.

d. No points will be awarded under mission critical if the package does not meet criteria shown at 4a, 4b or 4c.

#### 5. National Defense: (See paragraph 8 Definitions further defined)

a. Ten points may be assigned under the National Defense Category for those work packages that serve both an O&M Civil Works Need and a National Defense purpose such as military Port Readiness and Department of Defense Ports; such as, Naval Bases and Naval Shipyards. (See paragraph 8 Definitions further defined)

b. No points will be awarded under National Defense if the package does not meet criteria shown at 5a.

#### 6. Subsistence Harbors:

a. Ten points may be assigned under the Subsistence Harbors to work packages that support Subsistence Harbors. To qualify as a Subsistence Harbor the harbor

must be shallow draft and the community must be dependent on the harbor for its livelihood. (See paragraph 8 Definitions further defined.)

b. No points may be assigned to work packages under Subsistence Harbors that does not meet the criteria shown at 6a.

7. If any work package contains legal requirements, that package shall be flagged so that the work package can receive special attention. Legal requirements exist because of past actions by the Corps that have been determined to be a legal liability. The action on these work packages must be taken to prevent civil and/or criminal penalties. This work package to be flagged requires legal determination from Office of Counsel.

8. Definitions further defined:

a. National Defense Dredging is performed in accordance with regulations and provides an associated direct service to Department of Defense. It provides congressional approved depth or width in order for Defense Vessels to navigate for the purposes of egress and ingress from and into Homeports. This includes:

- Military Port Readiness in support of deployment and re-deployment of Military equipment during mobilization or national emergency.
- National Defense Shipyards for vessel construction and repairs.
- Projects Funded pursuant to Section 117 of Public Law 90-483, River and Harbor and Flood Control Act of 1968, the Corps uses Civil Funds for the maintenance of excess depths required and constructed for defense purposes where the project also serves essential needs of general commerce.

b. Subsistence Projects: Waterway serves as primary form of transportation for people, key goods or services. The community depends on Corps dredging to survive.

9. All of the points for each work package will be put into an excel spreadsheet program that will calculate the assigned points along with other points that are derived from economic and tonnage factors for each project.

## **SAD Hydropower Criteria**

### ***SAD FUNCTIONAL AREA RANKING MATRIX (FARM)***

#### **Hydropower Business Function**

The following seven criteria will be used to develop the funding priority of each level 2 and level 3 work packages. The following are the criteria, the measures for each, and the scoring scale.

### **MISSION IMPACT**

#### **Impacts Ability to Perform Project Mission**

Effect on achieving Project Mission in Budget Year:

Failure prevents accomplishment of project mission = 25

Failure impedes accomplishment of project mission = 12

Failure has no impact on project mission = 0

#### **Condition of Work Item**

Moderate deterioration. Function is still adequate = 15

Some deterioration or defects are evident, but function is not significantly affected = 9

Only minor deterioration or defects are evident = 3

*Score for Mission Impact = \_\_\_\_\_*

### **CUSTOMER IMPACT**

Economic impact to customer in budget year.

Avoidance of significant economic impact to customer due purchase of replacement power = 25

Avoidance of moderate economic impact to customer = 12

No economic impact to customer = 0

*Score for Customer Impact = \_\_\_\_\_*

### **FEDERAL REVENUE GENERATION**

Impacts of work item on projects inability to produce income in the budget year due to loss of capacity and energy revenue.

Inability to pump = 25

Significant inability to generate revenue (outage repair time greater than 3 months) = 15

Moderate inability to generate revenue (outage repair time 2 to 3 months) = 10

No inability to generate revenue = 0

*Score for Federal Revenue Generation = \_\_\_\_\_*

## **REDUCTION OF FUTURE O&M COST**

Spend Now and Save Later.

Reduction of future work item costs if awarded in the budget year (savings in contract cost vs. awarding 1-2 years later):

Cost savings of 15% or more of the work item cost = 10

Cost savings less than 15% of the work item cost = 5

No cost savings = 0

Reduction of future maintenance cost if awarded in the budget year (avoidance of O&M cost in years prior to award):

Cost savings of 25% or more of the O&M cost = 10

Costs savings less than 25% of the O&M cost = 5

No cost savings = 0

*Score for Reduction of Future O&M Cost = \_\_\_\_\_*

## **STAKEHOLDER CONSIDERATIONS**

Stakeholder Consideration or Public Interest/Relations Considerations in the Work Item.

Specific interest in work item due to reliability issue = 25

Moderate interest in work item due to reliability issue = 15

No interest = 0

*Score for Stakeholder Considerations = \_\_\_\_\_*

## **ENVIRONMENTAL IMPACT**



Environmental Compliance Issues.

Significant improvement = 5

Moderate improvement = 3

No improvement = 0

*Score of Environmental Impact* = \_\_\_\_\_

## **SAFETY**

Importance of Funding the Maintenance Items in Sustaining a Safe Environment.

(Note: Items presenting an immediate hazard should be rectified from Current Year O&M Funds.)

Identified as a safety issue in any formal inspection report = 10

Otherwise = 0

*Score for Safety* = \_\_\_\_\_

Ranking Score Total = \_\_\_\_\_

## **SAD Environmental Stewardship Criteria**

### ***Evaluation Criteria***

### **Environmental Stewardship Work Packages**

This is a tool for defining importance and assigning priority to work packages in the Environmental Stewardship business function. Individual work packages should be evaluated against each of the following criteria. Under each criterion, select the factor appropriate for the work package and assign its point value to achieve a point total for the package.

#### **Criterion 1: Basis for Work (Why this Work is being Performed)**

Legal Mandate and Formal Commitment ..... 4 points

Legal Mandate ..... 3 points

Formal Commitment or Expressed Political Interest ..... 2 points

Regulatory Requirement ..... 1 point

**Criterion 2: Impact to the Project (Adverse Effects if this Work isn't Performed)**

High ..... 3 points

Medium ..... 2 points

Low ..... 1 point

**Criterion 3: Other Impacts (Scope of the Influence Generated by this Work)**

National Impact ..... 3 points

Regional Impact ..... 2 points

Local Impact ..... 1 point

**Criterion 4: Tier II Performance Measure (Work Supports Goals of a Tier II Performance Measure)**

Yes ..... 2 points

No ..... 1 point

**Criterion 5: Status (When the Work was Scheduled To Be Accomplished)**

Backlog ..... 2 points

Programmed ..... 1 point

**Point Total for the Work Package** ..... \_\_\_\_\_

**Definitions**

**Legal Mandate** – Work required by Public Law, Executive Order, or some other legal mandate, “compliance” requirements.

**Formal Commitment** – Work required through formal commitments with other entities to accomplish actions. Examples of formal commitments include MOUs/MOAs, treaties, cost sharing agreements, partnering agreements, volunteer agreements, etc.

**Expressed Political Interest** – Work program supported publicly or in writing by local, state, or Federal elected officials.

**Regulatory Requirements** – Work required by regulation (ARs, ERs, DvRs), SOPs, and other such directives.

**High Impact** – Adverse effects to one or more of the project's Congressionally authorized purposes (Recreation, Navigation, Water Quality, Water Supply, Hydroelectric Power, Fish/Wildlife, Flood Control, Low Flow Augmentation, Irrigation, Salt Water Intrusion).

**Medium Impact** – Adverse effects to more than one business function (Navigation, Hydropower, Recreation, Flood Damage Reduction, Environmental Stewardship).

**Low Impact** – Adverse effects limited to the Environmental Stewardship business function.

**National Impact** – Work package influences are felt within more than one region, have nationwide implications, could be precedent setting, or could affect decisions and policies on a national level.

**Regional Impact** – Work package influences are felt within more than one state or more than one District. Could affect relationships with other agencies with regional responsibilities.

**Local Impact** – Work package influences are felt within the project boundaries and local communities.

**Programmed** – Work that is scheduled to be accomplished in the program year based on a 1- or 5-year work plan.

**Backlog** – Work budgeted in a preceding program year but unaccomplished.

## SAD Flood Damage Reduction Criteria

### *Evaluation Criteria*

#### **Flood Damage Reduction Work Packages**

This is a tool for determining importance and assigning priority to work packages in the Flood Damage Reduction business function. When putting work packages together, these criteria should be used to formulate the funding argument. Individual work packages will be evaluated against each of the following criterion. Under each criterion, select the factor appropriate for the work package and assign a point value to achieve a point total for the package.

#### **Criterion 1: Basis of Work (Why is this Work Being Performed)**

Legal Mandate and Formal Commitment .....	6 points
Legal Mandate .....	5 points
Formal Commitment .....	4 points
Dam Safety Requirement or Technology Upgrade to Reduce Costs .....	4 points
Regulatory Requirement .....	3 points
Authorized Purpose, Normal Operations & Maintenance Costs .....	2 points
Expressed Political Interest .....	1 point

#### **Criterion 2: Impact to The Project (Adverse Effects if this Work isn't Performed)**

Critical .....	10 points
High .....	6 points
Medium .....	3 points
Low .....	1 point

**Criterion 3: Other Impacts (Scope of the Influence Generated by this Work)**

National .....3 points

Regional .....2 points

Local ..... 1 point

**Criterion 4: Tier II Performance Measure (Work Supports Goals of a Tier II Performance Measure)**

Yes .....2 points

No ..... 1 point

**Criterion 5: Will Provide Updated/Real Time Data (Current Data Out of Date)**

Yes .....2 points

No .....0 points

Point Total for the Work Package.....\_\_\_\_\_ points

**Definitions**

**Legal Mandate** – Work required by Public Law, Executive Order, or some other legal mandate. This would be a rare requirement for Flood Damage Reduction (FDR) business function. An example would be endangered species discovered on the project and Federal Law required expenditure of government funds to protect the species and still operate and maintain the project. Another example might be the requirement to provide an Environmental Impact Statement for the project (i.e., some older projects have never had an EIS and NEPA requires one for all projects).

**Formal Commitment** – Work required through formal commitments with other entities to accomplish actions. Examples of formal commitments include MOUs, MOAs, treaties, and cost sharing agreements.

**Dam Safety Requirement** – Some action that was mandated as a result of a PICES or other formal Dam Safety Inspection that resulted in a written report requiring the action.

**Technology Upgrade To Reduce Costs** – Generally considered to be purchases of equipment that will provide better data at a reduced cost. Cost reductions could be realized in the collection, compilation, analysis, or transmittal of data.

**Regulatory Requirement** – Work required by regulation such as ARs, ERs, DvRs, and other such directives.

**Authorized Purpose** – Proposed work will support one of the Congressionally Authorized project purposes. This would normally be your annual O&M funding requirement.

**Expressed Political Interest** – A work activity supported in writing by a U.S. Representative or Senator.

**Critical Impact** – Failure to perform the work could result in failure of portions or sections of the structure. The result of such failure would be a probable loss of life as well as residential and commercial property in the downstream area.

**High Impact** – Failure to perform the work could result in failure of portions of the structure(s) and result in possible flooding of residential and or commercial areas. Loss of life would be unlikely.

**Medium Impact** – Failure to perform the work could result in failure of part of the structure with the potential for flooding agricultural and/or forest land. Threat to life or property is minimal.

**Low Impact** – Failure to perform the work will not result in failure of the project. However, continued lack of funding will lead to greater repair costs in the future.

**National Impact** – Work package influences are felt within more than one region, have nationwide implications, could be precedent setting, or could affect decisions and policies on a national level.

**Regional Impact** – Work package influences are felt by more than one state or more than one district. Could affect relationships with other agencies with regional responsibilities.

**Local Impact** – Work package influences are felt within the project boundaries and local communities.

**Tier Ii Performance Measures** – Work package is necessary to meet requirements of performance measure.

**Updated / Real Time Data** – This applies mostly to proposed studies to update water control manuals, flood damage calculations programs, or other studies that will provide updated data on critical programs.

### **Recommendations**

We recommend that environmental compliance work packages grouped under the FDR business function (table C-2.3a of EC 11-2-177) be drafted and rated using the rating criteria in the Environmental Stewardship model and not the model developed for FDR.

## Appendix L: Minutes - St. Louis Meeting May 2001

### Attachments

Participants: Attachment 1, pg 205

Meeting Agenda: Attachment 2, pg 206

All presentations, butcher paper notes, etc available upon request from:  
[d-mckay@cecer.army.mil](mailto:d-mckay@cecer.army.mil)

1. **Background:** The “Civil Works Operations & Maintenance Management Tools” research and development (R&D) program is sponsored by the USACE Directorate of Civil Works Operations Division. Mr. Jim Hilton (CECW-O, 202-761-XXXX) is the program’s current sponsor and technical monitor. The program’s execution is the responsibility of the Engineer Research and Development Center (ERDC). The program manager is Dr. Paul Howdysshell, the principal investigators are Mr. Stuart Foltz and Mr. Dave McKay. The program is managed and executed from the Construction Engineering Research Laboratory (CERL), Champaign, IL. The program, in part, is intended to bring closure to incomplete products from the Operations Management problem area of Repair, Evaluation, Rehabilitation & Evaluation (REMR) R&D program which concluded in 1998, but has new products too.
2. **Problem:** Inconsistent program objectives and priorities have been set before the ERDC R&D team. The two prime reasons for this are (a) the technical presentations by the ERDC staff have been too long and too detailed, which has overwhelmed audiences, and (b) frequent changes in membership of the program’s Field Review Group (FRG) have made it necessary to spend a lot of time reviewing old accomplishments rather than new progress. As a consequence, inconsistent perceptions of what the products are supposed to do caused confused and semi-confident voting that could apparently be swayed one way or another. At the last FRG (AUG00), program priorities were the reverse of the previous FRG and one objective with formerly medium priority was entirely dropped.



This shifting focus has created tactical problems in progressing toward the original program goals.

3. **Solution Approach:** It was decided by the ERDC staff to convene a Field Advisory Board (FAB) comprised of USACE personnel whose job responsibilities make them the most likely people to directly benefit from the developed products. The FAB could provide more detailed (and critical) feedback to both the ERDC researchers and the FRG. Input from such a group could increase credibility and FRG confidence in the ERDC team.
4. **Preliminaries, Objectives, and Presentations:** The FAB convened and met at St. Louis during 04-06MAY01. The meeting more or less followed the original agenda's format of several (PowerPoint) presentations, each followed by group discussion. For such meetings in the future, this format should work well but the amount of attention paid to minute and technical detail was, again, deemed too much and unnecessary. In any case the meeting began and adjourned on schedule. All presentations, handouts, and an electronic copy of the butcher paper record are available as listed above. Part 5 of these minutes covers the discussion that followed the presentations.

A. The **OBJECTIVES** for the meeting were identified as

- i. Provide guidance, recommend appropriate thrusts and products for the R&D program to the program's FRG and ERDC staff.
- ii. Recommend plans for implementation of the R&D program products to the program's FRG and ERDC staff.
- iii. Form a subcommittee for the purpose of developing an independent prioritization model for maintenance work packages.
- iv. Create and adopt a Charter to provide the framework for future meetings and activities.

- B. **SPECIAL TASK:** Ken B. shall prepare and deliver a briefing to Chief of Operations, CECW-O. Prior to convening the FAB, during a private conversation with CECW-O Chief of Operations, he indicated that he was interested to hear about the outcomes of this meeting. At the time of this writing the briefing is scheduled for early August 2001.

C. The program **WORK UNITS** were presented with attention paid to the goals and associated issues, as interpreted by ERDC researchers at the time of presentation, for each\*:

i. WU: CONDITION INDEX SIMPLIFICATION

a. Goals

- (1) Make existing condition evaluation procedures simpler and cheaper with the intention of promoting more widespread use by the Corps.
- (2) Draw data from existing sources as much as possible
- (3) Finish uncompleted systems
- (4) Create new systems where demand is evident
- (5) Investigate enhancements for better or cheaper information
- (6) Uniform & Consistent (Repeatable) Process: quantify condition (snapshot), articulate needs, common vocabulary, facilitate trust

b. Issues

- (1) No corporate policy on who, when, where, why, for CI usage and storage
- (2) No recognition/payback from HQ for using CIs
- (3) Current benefits realized best at Project and District levels
- (4) Broader and greater benefits realized at Division and Headquarters levels if everyone uses CIs in same way

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\* After these presentations were delivered, subsequent discussion led to modification of some of the goals, or issues, or both.

- (5) Software outdated

ii. WU: MAINTENANCE PRIORITIZATION

a. Goals

- (1) Explicit statement of prioritization criteria
- (2) Multi attribute sorting algorithms for non-deferrable Level II ABS (or nonrecurring maintenance) work packages
- (3) Not just CIs, must include other common criteria (e.g., customer impact, regional or national impact) and risk (consequences of not doing the work).
- (4) Performance analysis, return on investment or other economic metric
- (5) A process enabling objectivity, trust, defends/supports human decisions

b. Issues

- (1) This work unit was originally titled Benefits Analysis but was changed in name and focus to Prioritization. The original intent was to obtain economic benefit associated with a given work package, which would have played a major role in prioritization. The change to focus only on prioritization resulted in a target product that only provides ordinal ranking of work packages.
- (2) Currently this tool's most valuable use is at Division level during determination of program requirements (APR-MAY)
- (3) Comparisons across business areas very difficult (e.g., recreation vs. hydropower)
- (4) Comparisons across Projects, Districts, Division?

- (5) Target 60-70% ranked “correctly”? The ranking should assist the process and add objectivity but not replace all subjective priorities.
- (6) Currently only needed for  $\pm 10\%$  of cut line; should this be expanded (e.g., include baseline)?

iii. WU: O&M BEST PRACTICES WEBSITE

a. Goals

- (1) Resource: lists cost saving technologies that have been proven successful at least one site, but has not been widely adopted by the Corps.
- (2) Provide direct contact to people who developed and/or used the technology, and hyperlinks to guidance, technical reports, or other information concerning the technology
- (3) Provide a forum for public exchange of experiences using the technology

b. Issues

- (1) What is the implementation plan? Where does it belong and how should it be supported?
- (2) What additional features should the web site have (e.g., lessons learned)?

iv. WU: SUMMARY READINESS METRIC (SUMMARY INDEX)

a. Goals

- (1) Quantify the condition, functionality, or readiness of a project and/or a collection of projects
- (2) Create a composite index to relate the condition and functionality of component structures within a work package

- (3) Serve as a metric much like a stock index to reflect the overall “corporate health” or readiness of a collection of infrastructure
- (4) Can quantify the impacts of budget shortfalls on project or global scope, by using such an index
- (5) The SI could also be a simple objective measure of a need for increased funding (e.g., ASCE report card)
- (6) Not necessarily CI based

b. Issues

- (1) Was originally in program but dropped by FRG of AUG00
- (2) Of questionable value at Project and District levels
- (3) Precision level undetermined
- (4) Was an upper management idea (J. Crews) to begin with

5. **Discussion:** The primary concerns voiced at the meeting were not so much about the progress of the R&D or the products (goals and issues) themselves, as they were over the matter of who is going to use the products, how are the products to be used, and what was the best way for integrating the products into the O&M business process. For the most part the issues cited with each work unit were addressed, but not necessarily in the same chronological or associative order as shown in part 4 (above). The following paragraphs are organized to cite the general topics covered and relevant discussion over each one:

**A. Who is the customer?**

There was brief but confused discussion over who the customer(s) are for these products. While some of the CI evaluation procedures are being regularly used by a few Districts, routine usage does not extend beyond or above the District level. Prioritization schemes are being used by some Divisions during the APR-MAY sequence of the budget cycle. But by and large, the HQUSACE in and of itself is not using the CI or the prioritization tools. Therefore some argued that the ones who are using the products are the customer. Some people believed

that HQUSACE is the customer as they ultimately are paying for the R&D, even though long-term plans for infusion of CI into the business process have not been made. It was also noted during this discussion that, so far, a limited number of CI systems exist for navigation, flood damage reduction, and hydropower infrastructure. There is no equivalent for dredging operations, which represent the largest part of the O&M budget. This question was not clearly resolved, but the discussion eventually led to the conclusion that all players are customers and should have equal access in determining how the products should be used.

Along the same lines when discussing HQUSACE's use of these products, the question was asked: "Can they (CECW-O) use these products to explain why they can't deliver customer service, or how much it will cost?" Such is seen as one of the primary purposes of the CW Tools program. One immediate use of the products is that they answer a need for a common language for communication up and down the stove-pipe (or rather, across the PMBP).

#### **B. How (and why) should the R&D products be brought into the real world?**

A point that was repeatedly made during the meeting was that the *process* of determining CIs, priorities, relative needs, etc. are just as important as the end. The processes do not replace human judgment and never should; they support decisions and should be used to convince others that the right decision has been made. The processes demonstrate that discipline was used to arrive at a decision, which makes the decision more believable and convincing. It was generally agreed that within any implementation plan the processes should be open to everybody with equal access.

If these products are to be used as a matter of policy then these products should be integrated into the business process and HQUSACE must become an active player and perhaps even an enforcer. Care must be taken to ensure overlap does not occur with other R&D activities; other agencies may be producing similar tools (e.g., BUREC, TVA, NPS). Opportunities for the products to complement other processes or analyses (e.g., risk and reliability) should be sought.

A potential use for the tools would include forecasts of changes in condition. Long range and short range forecasts should be one of the goals. With such forecasts, customers (and the general public) could be informed and use the information for their own purposes. However, forecasting requires regular and periodic collection of data, which is not happening as a matter of course today.

**C. What about consistent use of the tools (e.g. prioritization criteria) across the nation, or across business function, how can this be done?**

Each piece of data must have a consistent meaning and interpretation to everybody. This gives rise to the question of how can a tool provide Corps-wide consistency across uniquely different business functions? This will be extremely difficult to accomplish because the economic drivers are not the same everywhere. If something that is universally acceptable cannot be developed then usage of the product may have to remain local and cannot contribute to a national comparison. There is an effort along these lines going on in South Atlantic Division. They are now looking at ways to prioritize work within business functions. The FAB discussion continued along these lines with no cogent resolution. A summary metric of some kind may be useful in addressing this dilemma (see paragraph M. ).

**D. What about management by Just In Time Maintenance strategy?**

Some expressed their concern that they are forced to manage their infrastructure by fixing only what breaks, or performing maintenance just prior to breakdown. They ask what good are the tools when one must work under such a strategy? Also, the point was made that repairs in and of themselves are sometimes the biggest cause of outages. How can the products be useful in addressing accidents and other significant events? Again, the possibility of long and short range condition forecasts was discussed. Aside from the ability to quantify damage and/or other changes in condition, little more along these lines was discussed.

**E. Yet another unfunded mandate?**

The use of the tools must not be added to the list of unfunded O&M tasks. Rather the use of the tools should *replace* a process if they represent an improvement. The idea of using the tools to replace parts of the Periodic Inspection was put forward.

**F. What about the data created by the CW Mgmt Tools?**

The frustration of having to enter duplicate data in multiple places was clearly expressed. This frustration arises from all aspects of the O&M program, not

just the CW Mgmt Tools products. Every effort should be made across all of the O&M program to centralize data entry and any singular piece of data should be entered once and only once. The advent of Facilities and Equipment Maintenance System (FEMS) may go some distance towards alleviating this concern.

The software for CI is outdated; most of it is in DOS format and it is unknown how long this Operating System will remain compatible. Storage and reporting requirements should be able to be handled by FEMS.

#### **G. What about the EIG report?**

The Draft EIG report “Operations and Maintenance in the Program and Project Management Business Process” (FEB01) was briefly discussed in terms of the CW O&M Tools. The focus of the EIG was more on the failure of project managers to adopt the PMBP. The Tools might help address this problem in terms of their ability to help communication, but it remained unclear how and to what extent the tools should be utilized for this purpose. The group asked the question of whether the Prioritization process could address EIG findings:

#3. “District and Division commanders ensure that all work packages are consistently identified and prioritized in accordance with the current series of EC 11-2-XXX.”

#6. “Divisions continue their efforts in developing their decision support systems to more objectively prioritize their organization’s work packages.”

#### **H. What about Facility Equipment Maintenance System (FEMS)?**

Terry A. gave an impromptu presentation on FEMS. He is overseeing the contract for implementing it within the USACE Civil Works. FEMS will track principal items of property using commercial off-the-shelf software MAXIMO. In addition to tracking inventory and maintenance schedules, MAXIMO will be interfaced with CEFMS so that PR&Cs, labor authorizations, and other data may be organized according to local needs or requirements. The system has 12 modules (organizational hierarchy, equipment hierarchy, work orders, and others). It will be supported by two bases, one at Portland and the other at Vicksburg. The FEMS will be programmed to generate work orders for all imaginable tasks. A work order for performing a CI measurement, or any other task can easily be set up. Associated data can also be stored in it.



## **I. What about the CIs and Reliability?**

The USMA representative was invited to present the results of work he recently completed that considered relationships between the CI and Reliability analysis. His immediate focus was whether CIs could be used to upgrade existing deterioration models for corrosion or fatigue. He considered a sample problem of corrosion on a miter gate. His conclusion, simply, is that although the current design for corrosion type CIs do not accommodate Reliability, with a little bit of modification it could. In addition, as the Reliability analyses become more sophisticated the associated roles for CI will become greater, and that a potential exists to use CI data to update fatigue deterioration models.

The representative recommended that designers of CI systems talk with Reliability experts in order to improve the CI's ability to complement Reliability analyses, and to focus especially on how CI data can be used to quantify conditions in probabilistic terms (e.g., frequency of data collection in order to quantify a transition state). He further recommended HQUSACE oversight for funding a more formalized program for development, training, and periodic mandatory use. The complete presentation titled "CI ST Louis presentation.ppt" is available at <ftp://ftp2.cecce.army.mil/pub/Disco%20Boy>.

## **J. What about the CI work?**

The effort to simplify the process of collecting condition data and generating indexes should continue. The group recognized that the CI procedures as they are used today help some organizations but not everybody. Today, CI systems use is voluntary but at one time they were part of the Budget EC. Because of ambiguities between the EC and the ABS reporting system, the CI was dropped as a budget-reporting requirement. It was evident that HQ was not looking at the information seriously, however it was noted that the process alone provides a degree of consistency and open communication. As practiced today, most benefits are realized at the project and district levels. However, ideally, the greatest benefit can be realized when the CIs are not only used *at all levels*, but with a consistent process for usage and reporting.

Data should be obtained where possible by looking in data resources that already exist, examples include FEMS, VERS, NRMS, LPMS, OMBIL, etc; CI data should also be validated by looking at the same resources. Software using

relational databases should be developed in lieu of the outdated DOS format of existing CI computer programs.

The resulting products should be used to replace existing processes instead of creating new and additional work. CI indexes and raw inspection data should replace appropriate sections of the Periodic Inspection of completed structures. With FEMS coming online soon, data collection should be compatible with it. Other facility-specific inspection processes such as Dam Safety, Bridge, and QA inspections should be set up as work orders in FEMS as well. However, proponents for certain inspections should routinely review the CI data as it is collected or at least prior to executing the inspection; with special attention paid to changes in data.

CI may have other applications. For such uses, special algorithms should be derived with the oversight of an expert group. An example of this could be a Summary Index, as a rollup of CI and other types of data, or Reliability analyses, etc.

#### **K. What about the Prioritization Work?**

An argument was put forth that the R&D on the prioritization work was completed since successes were realized in the SWD and LRD divisions. This work has most recently focused on the ABS work packages defined as “non-deferrable”. The group in whole neither supported nor rejected this argument and only the research side suggested there were needs not met by the LRD and SWD ranking algorithms.\* Besides work package prioritization, these efforts could lead to more advanced algorithms that might be able to quantify actual (as opposed to relative) benefits associated with O&M investments. Further, if changes in condition bring about improved performance, O&M investments can be related to changes in condition/functionality, perhaps enabling forecasts of budget needs. In any case, the final recommendations indicate that the group was in favor of seeing more from this line of investigation because: (a) it provides a process to uniformly prioritize work, (b) helps the MSCs assure they are putting money in the right places, (c) the research has potential to lead to more powerful products.

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\* None of the FAB members have been direct participants in the development and use of the prioritization tools although one person played an oversight role in those activities.

The prioritization work should look into work that is being done in the ongoing Ohio River Main stem System Study. One of the things that they are attempting to do is to compare the physical conditions of the locks and dams on the Ohio River, run some risk analyses to further determine which elements of the physical condition are most critical, and then end up with the priorities for investments for the entire river.

With the advent of PROMIS II, rumor says that the ABS will be absorbed. In any case, prioritization schemes should be prepared to be loaded into PROMIS.

The labs should create a model process or framework for other divisions to try. Again, the benefits of using a systematic process being of great value. Another noteworthy observation was made that O&M budget planning is done in the Budget Year (FY+2), and that these schemes have no influence over real time execution. But in a reprogramming situation, the schemes can again be used to justify and support decisions.

#### **L. What about the O&M Handbook web site?**

The O&M handbook was soundly deemed as a useful and worthy product and should be made known Corps-wide and supported for the long term. A letter, or Memorandum Of Record has been drafted for the CECW-O Chief's signature, recommending that all USACE O&M home pages contain a hyperlink to it.

A lessons-learned module should be added. This can be a continuing ERDC function but needs an HQUSACE proponent. As a simple web site, the costs associated with development and long-term support are such that this effort lays within regulatory requirement of ITIPS (requiring minimal approval) and has no requirement under LCMIS (requiring expensive and time consuming documentation).

#### **M. What about Summary Index?**

The concept of an overall encompassing metric perhaps called a Summary Index (SI) or a Report Card was discussed to some length. The group exhibited enthusiasm and saw potential value in developing a metric akin to the ASCE's annual report card on the health of the nation's infrastructure. It should be a simplified grading system the public can easily understand such as A, B, C, ...F. There should be a pass-fail point in the grading system. The SI could have subcompo-

nents broken out according to business function (e.g., Navigation, Flood Control, Hydropower, Environmental Restoration, Recreation, Water Supply). An SI type of metric should be developed at the project level, which is something similar to what is being considered in the ongoing Ohio River Main Stem study. The SI relates a simple status of readiness that is relevant to customers and can reflect physical state of facilities, expected levels of service, and/or reliability information. Customers and stakeholders might use such a Report Card as an inspiration to write letters to their congressman. A rollup SI could even go so far as to give HQUSACE something to defend its budget requests to the administration, OMB, and Congress.

The SI or Report Card should only give a current status or readiness report. No attempt to directly or explicitly bind the SI to the budget should be considered. It should not be used as a prioritization tool nor as a tool for funds allocation. Impacts of budget shortfalls might be compared to the SI, but any explicit examination of changes in status or readiness in relation to funding levels would/should be derived from the a combination of the CI and prioritization work units.

The metric should be based on factual information or data that are measurable. Results should be repeatable and independent of who performs the evaluation. Any system developed should make maximum use of existing information such as periodic inspections, condition indices, dam safety inspections, quality assurance inspections, maintenance data and the like. The metric should cull input from environmental concerns, customer surveys, and more. The validity of the rating can be established by comparing it to other readily available information.

The ERDC should be doing the developmental work but there should be a PAT to oversee the development, progress, and presentation of the product. A review of what standards (if any) that are being used by other agencies along these lines must be considered (e.g., ASCE, TVA, BUREC, NPS). These same groups could provide peer review of the final product.

The SI or Report Card must be compatible with ongoing efforts with the USACE such as the rating of projects as done within the PMBP. Master plans for operations, safety, health, etc. should be considered.

The SI should be assessed at least annually so that the result is believable as a real time assessment. Simplicity must be stressed, a simple matrix format should be considered for calculating the SI. In order for the districts to buy into the process HQUSACE (or the oversight committee) must provide fair and equi-

table policing and regulation. The SI should be incorporated into the Chief's and in each Division Commander's annual status report to the Congress. A rapid implementation of this product is recommended.

## 6. Conclusions:

A. **OBJECTIVE I:** Provide guidance, recommend appropriate thrusts and products for the R&D program to the program's FRG and ERDC staff.

i. The Simplified Condition Index work should continue with added attention towards developing compatible data for input to the SI.

ii. The Prioritization work should continue with the objective of creating a generic framework for other divisions to follow. Efforts in this work unit may also provide useful routines for assessing potential benefits obtainable by proposed changes in condition and or performance resulting from an O&M investment.

iii. The O&M Best Practices Handbook should be supported. A lessons learned module should become an added feature.

iv. The Summary Index is popularly supported. The work unit for the SI should be reinstated.

B. **OBJECTIVE II:** Recommend plans for implementation of the R&D program products to the program's FRG and ERDC staff.

i. The Simplified Condition Index effort should include making CI routines compatible with, or suitable for replacing appropriate pieces of the Periodic Inspection procedures. A corporate policy regarding execution as part of the Periodic Inspections should be developed.

ii. The Prioritization work should be readily exportable to PROMIS.

iii. O&M Best Practices Handbook. Should have a proponent and a long range support plan

iv. Summary Index. A proponent and oversight committee should be established. Recommendations reflected in the minutes should be followed.

- C. **OBJECTIVE III:** Form a subcommittee for the purpose of developing an independent prioritization model for maintenance work packages.

This was not discussed to great length. If the FAB reconvenes the topic will be considered. Alternatively a working group could be formed independently of the FAB.

- D. **OBJECTIVE IV:** Create and adopt a Charter to provide the framework for future meetings and activities.

It was decided to defer any work on a FAB charter until after Ken B.'s report to Charles H. Depending on Mr. H.'s response, the FAB may reconvene and adopt a charter.

- E. **SPECIAL TASK:** Ken B. shall prepare and deliver a briefing to Charles H., Chief Operations, CECW-O. Prior to convening the FAB, Ken B. had a private conversation with Mr. H. who indicated that he was interested in hearing about the outcomes of this meeting. At the time of this writing the briefing is scheduled for early August 2001.

7. ATTACHMENT 1, PARTICIPANTS

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## 8. ATTACHMENT 2: MEETING AGENDA

Note that all presentations and files are at: <ftp://ftp2.cecer.army.mil/pub/Disco%20Boy/>

### *Monday, 30 April 01*

*1300 Introductions*  
*1315 “Why are we here?” (Dave McKay)*  
*1330 Discussion*  
*1400 Review Draft Charter*

### *1430 Break*

*1445 Resume Review Draft Charter (as needed)*  
*1530 “CW Tools overview MAY01” (Dave McKay)*  
*1550 Discussion*  
*1615 “Glossary of topics” (Stuart Foltz)*  
*1645 Discussion and/or adjourn*

### *Tuesday, 01 May 01*

*0800 “CI simplification (minutiae)” (Dave McKay)*  
*0820 Discussion*  
*0830 “Multi-level inspections” (Dave McKay)*  
*0850 Discussion*

### *0920 Break*

*0940 “CI checklists” (Stuart Foltz)*  
*0950 Discussion*  
*1010 “CI’s as risk screening tools” (Stuart Foltz)*  
*1040 Discussion*  
*1100 “CI input to Reliability” (Al Estes)*  
*1130 Discussion*

### *1145 Lunch*

*1245 “CI enhancements” (Stuart Foltz)*  
*1305 Discussion*  
*1315 “CI inspection data management” (Dave McKay)*  
*1330 Discussion*



*1345 Discussion of CI roles*

*1415 Break*

*1430 “EIG report” (Stuart Foltz)*

*1445 Discussion prioritization needs*

*1500 “Division prioritization tools and CERL’s role” (Stuart Foltz)*

*1530 Discussion of prioritization roles*

*1600 Break*

*1615 “Summary Indexes” (Stuart Foltz)*

*1630 Discussion*

*1645 Adjourn*

*Wednesday, 02 May 01*

*0800 “O&M Best Practices Handbook” (Dave McKay)*

*0810 Discussion*

*0830 Corporate policy initiatives*

*1000 Break*

*1030 Action items*

*1130 Lunch*

*1230 Action items (cont)*

*1330 Last go around*

*1400 Next meeting*

*1430 Adjourn*



## Appendix M: List of Completed Condition Assessment Systems

### Coastal breakwaters and jetties

rubble mound – Technical Reports REMR-OM-11, -OM-20, -OM-24;  
Technical Note OM-MS-1.5

nonrubble and hybrid – Condition Assessment Methodology of Spillways,  
draft ERDC/CERL technical report

Concrete gravity dam spillway, retaining wall, and pier monoliths – Technical  
Reports REMR-OM-16, -OM-22; Technical Note OM-MS-1.10

Concrete lockwall monoliths – Technical Reports REMR-OM-4, -OM-10, -OM-12;  
Technical Note OM-MS-1.2

Dam gate, lift and sluice - Condition Assessment Methodology of Spillways, draft  
ERDC/CERL technical report

Dam gate, roller – Technical Report REMR-OM-18; Technical Note OM-MS-1.13

Dam gate, tainter – Technical Report REMR-OM-17; Technical Note OM-MS-1.14;  
Condition Assessment Methodology of Spillways, draft ERDC/CERL technical  
report

Embankment dams – Technical Report REMR-OM-25

Hydropower components – (unpublished loose-leaf notebook)

electrical circuit breakers  
electrical excitation systems  
electrical hydro generator stators  
electrical main power transformers  
electrical power house automation systems\*\*  
mechanical cranes and wire rope gate hoists

- mechanical governor systems
- mechanical hydraulic actuator systems
- mechanical intake valves
- mechanical thrust bearings\*\*
- mechanical turbines
- structural emergency closure gates
- structural power penstocks\*\*

\*\* not included in Condition Assessment Guides being developed by HDC with Hydro-Québec, Bonneville Power District, and Bureau of Reclamation (to be published soon).

Lock and dam gate operating equipment – Technical Report REMR-OM-19; Technical Note OM-MS-1.12; Condition Assessment Methodology of Spillways, draft ERDC/CERL technical report

- cable (wire rope)
- chain
- coupling
- enclosed gears
- exposed gears
- gear rack
- hydraulic piston/cylinder
- rocker arm
- strut arm

Lock gate, miter – Technical Reports REMR-OM-7, -OM-8, -OM-15; and Supplement Technical Note OM-MS-1.3

Lock gate, sector – Technical Report REMR-OM-13, -OM-15; Technical Note OM-MS-1.7

Lock gate, tainter – Technical Report REMR-OM-17; Technical Note OM-MS-1.14

Lock valve, butterfly and tainter – Technical Report REMR-OM-14, -OM-15; Technical Note OM-MS-1.11, OM-MS-1.8

Riverine stone training dikes and revetment – Technical Reports REMR-OM-21, -OM-23; Technical Note OM-MS-1.9

Riverine timber dikes (Columbia River) – Technical Report REMR-OM-5; Technical Note OM-MS-1.6

Steel sheet pile walls and cells – Technical Reports REMR-OM-3, -OM-9, -OM-15; Technical Note OM-MS-1.4

Spillway gates – Condition Assessment Methodology of Spillways, draft ERDC/CERL technical report

operational components:

- river flow measurement
- reservoir level indicator
- precipitation and temperature gauge network
- snow measuring stations
- weather forecasting
- ice and debris management
- third party data
- gate position indicator
- flow prediction model
- decision process
- telecommunication system
- public protection and warning system
- availability and mobilization (design flood)
- availability and mobilization (load rejection)
- operating procedures
- qualification and training of operator
- portable equipment for lifting gates
- road
- alternate means of access
- local access
- remote and onsite controls

electrical components:

- overhead lines
- local or emergency generator
- underground and encased cables (medium voltage)
- power feeder cables (low voltage)
- transformer
- power source transfer system

- ice prevention system (air bubbler)
- lighting system (normal and emergency)
- limit switches
- ice prevention system (heating)
- distribution panel
- translation motor (electric)
- lifting motor (electric)
- motor control center or individual control panel
- cam switches
- external resistors
- inverter control system

mechanical components:

- screw and nut (screw-type hoist)
- bearings
- split bushing or journal bearing
- rotating shafts, supports, bearings, and couplings
- gear assembly (hoist)
- gear assembly (carriage)
- dedicated lifting connectors
- non-dedicated lifting connectors
- drum, sheaves, and pulleys
- hoist brake
- carriage brake
- fan brake
- wire rope and connectors
- trunnion assembly
- trunnion beam and anchorage
- chain and sprocket assembly
- hydraulic cylinder assembly
- fixed wheels for vertical lift gates
- roller trains

civil/structural components:

- carrying tracks
- lifting device structure
- mobile structure to support a shared lifting device
- approach and exit channel
- lifting device structure (steel)

- embedded parts
- tainter gate structure
- liftgate structure
- stoplogs, bulkheads (steel)
- bottom and side seals

Training and software programs for the above systems are available from the U.S. Army Engineer Research and Development Center/Construction Engineering Research Laboratory: [remr](#)

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